AD-A152 041 COOPER RIVER REDIVERSION PROJECT LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA COOLING WATER FACILITIES (U) SAVANNAH DISTRICT CORPS OF ENGINEERS GA 15 OCT 80 1/2

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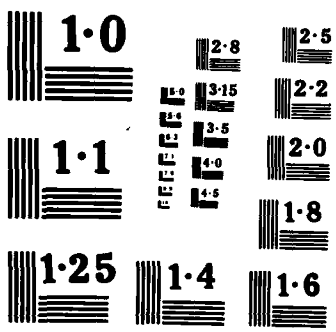
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DESIGN MEMORANDUM 13

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER
SOUTH CAROLINA

COOLING WATER FACILITIES

Prepared by the Savannah District, Corps of Engineers, Savannah, Georgia for the Charleston District — 15 October 1980

APPROVED BY THE CHIEF OF ENGINEERS ____________ 19 ___

E. D. FILE ______________________________

REVISIONS		
Date	New Pages and Drawings	Date Appvd by C: of E.

COPY NO. 60

N/A 12/17 ~~EA-CP~~
Mr. Harward

SADEN-GP (15 Oct 80) 1st Ind
SUBJECT: Cooper River Rediversion Project, Lake Moultrie and Santee River, South Carolina, Design Memorandum 13 - Cooling Water Facilities

DA, South Atlantic Division, Corps of Engineers, 510 Title Building, 30 Pryor Street, SW, Atlanta, Georgia 30303 16 December 1980

TO: District Engineer, Savannah, ATTN: SASEN-CP

The Cooling Water Facilities Design Memorandum is approved subject to submission of a detailed estimate on spray canal system and the following comments:

a. Before proceeding to construction, the acceptability of the proposed facility by SCPSA must be documented and become a part of the permanent record contract file.

b. The SCPSA letter of 11 August 1980 (Ex. F) contains an unacceptable request. There is no reported justification for the Government to give up its flexibility in utilizing the 3000 cfs discharge in any manner determined as most advantageous. Therefore, we see no justification for modifying the contract (Para. 76) nor could we find any District comment directed to this subject. In the absence of justification, this issue should be reconciled with SCPSA at the earliest opportunity.

c. Page 5, paragraph 20. Figure 19 is not identifiable in Exhibit A due to poor reproduction. We assume Figure 19 is on pages 26-28 of Exhibit A. However, the absicsa and ordinate of these graphs are not legible. Clarify.

d. Page 5, paragraph 20. Table 3 is not shown.

e. Page 6, paragraph 22. It should be explained why Table 1 and Table 2 differ and why Table 1 values are selected for the analysis of alternatives shown in Figure 1.

f. Pages 7 and 8. The power benefit equation should be explained.

g. Page 6, paragraphs 22 and 23. The District's analysis does not recognize that additional flows would not be required when normal releases are being made from Pinopolis, i.e., a part of the 10% of the time Units 1 and 2 operate, there will be adequate flows available.

h. Pages 15, 16, and 29. Cost estimates include a number of special items with special costs (i.e., 108" pipe, 84" and 96" butterfly valves, pumps, motors, tower w/PVC fill, etc.). Source and/or derivation of costs should be included in the report.

i. Page 16, paragraph 38. The calculation of the life cycle costs

SADEN-GP (15 Oct 80) 1st Ind 16 December 1980
SUBJECT: Cooper River Rediversion Project, Lake Moultrie and Santee River, South Carolina, Design Memorandum 13 - Cooling Water Facilities

shown in Tables 8, 9 and 10 for each alternative should be furnished.

j. Page 14, paragraph 36. The details given in this paragraph do not agree with those shown on exhibit C, page 6. Clarify.

k. Plates 3 and 4. The final layout for the project should be presented, including the grading plan.

l. Plate 6, Valve Vault A and B. Foundation grades for valve vaults A and B are at approximately elevations -22 and -26, which results in excavations to depths of approximately 50 feet. Boring CS-1 indicates a groundwater reading 18 hours after completion of the boring at a depth of 3.5 feet. The excavations and the dewatering for the vaults should be addressed in the report. Also, the effects (if any) of the dewatering for the vaults, as well as for the cooling water booster, an adjacent existing structures, should be addressed.

m. Exhibit H, page 2, paragraph 4.a. It is stated "The structural design should check the stability of the structure for uplift". This analysis should be presented in the report.

n. Plate 7. The foundation design for the Water Treatment Building should be addressed (foundation grade, allowable bearing capacity, need for a capillary water barrier and vapor barrier, etc.). It should be recognized that there is approximately a 15 ft. differential in the natural ground elevation from one corner of the building to the other.

o. Plate 9. The structural loading and design for the cooling tower basin foundation should be presented to substantiate the foundation design. Also, based on the quantities shown in Table 12, it appears that both steel H-piles (combination bearing and fricition founded in the dense silty sands) and auger cast piles (end bearing founded at top of rock) will be utilized. Consideration should be given to using only the auger cast piles which are end bearing on rock. This would eliminate the mobilization of pile driving equipment and eliminate the possibility of differential settlement between the end bearing piles on rock and the piles founded in the dense silty sand.

p. Plate 7. Design criteria for water treatment building should be submitted. In addition, alternate framing systems should be included in the memorandum.

FOR THE DIVISION ENGINEER:

wd all incl

William L. Lytton Jr.
for WILLIAM N. McCORMICK, JR.
Chief, Engineering Division

CF:
DAEN-CWE-BB, w/10 cys incl

EN-CP
CF: Mr Halliburton

DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT, CORPS OF ENGINEERS
P. O. BOX 889
SAVANNAH, GEORGIA 31402

REPLY TO ATTENTION OF: SASEN-CP

15 October 1980

SUBJECT: Cooper River Rediversion Project, Lake Moultrie and Santee River, South Carolina, Design Memorandum 13 - Cooling Water Facilities

Division Engineer, South Atlantic
ATTN: SADPD-R

1. I am transmitting 13 copies of subject Design Memorandum submitted for approval in accordance with applicable provisions of ER 1110-2-1150 dated 1 October 1971, and revised through Change 7, 22 July 1974.

2. I recommend that this Design Memorandum be approved as a basis for the preparation of construction plans and specifications for applicable portions of the project.

3. I request that your review and approval be provided on or about 15 November 1980, in order that we may maintain our current project schedule.

1 Incl (13 cys)
as

Tilford C. Creel
TILFORD C. CREEL
Colonel, Corps of Engineers
District Engineer

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

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TEXT (cont'd)

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COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

PERTINENT DATA

DRAINAGE AREA	**Square Miles**
Lake Moultrie	15,000
Lake Marion	14,700
RESERVOIR AREAS	**Acre-feet**
Maximum power pool	
Lake Moultrie	1,110,000
Lake Marion	1,450,000
Minimum power pool	
Lake Moultrie	450,000
Lake Marion	350,000
ELEVATIONS	**Feet, msl**
Top of dam	
Lake Moultrie	88.0
Lake Marion	88.0
Maximum water surface	
Lake Moultrie	75.2
Lake Marion	76.8
Top of gates	
Lake Moultrie	--
Lake Marion	76.8
Spillway crest	
Lake Moultrie	--
Lake Marion	63.0
Maximum power pool	
Lake Moultrie	75.2
Lake Marion	75.7
Minimum power pool	
Lake Moultrie	60.0
Lake Marion	60.0
Normal tailwater	
Lake Moultrie	7.2
Lake Marion	27.0
Minimum tailwater	
Lake Moultrie	-1.5
Lake Marion	26.0

PERTINENT DATA (cont'd)

WILSON DAM (Forms Lake Marion)	
Completion date	23 March 1942
Length - miles	7.8
Height of spillway - feet	48
Spillway	
Design capacity - cfs	800,000
Length - feet	3,400
Gates	
Number	62
Size - feet	14 x 50
PINOPOLIS DAM	
Completion date	2 Dec. 1942
Length - miles	1.4
Release capacity (cfs)	28,000
Powerhouse size in feet	185 x 380
Lock interior in feet	60 x 180
Lock lift in feet	75
Average annual release (cfs)	15,600
Powerhouse features	
Number of generators	4(1)
Generator capacity (kw)	30,600 (10,215)
Generator rating (kva)	34,000 (11,350)
Total generating capacity (kw)	132,615
Number of turbines (Total)	5*
No. fixed-blade turbines	2
No. adjustable-blade turbines	2(1)
Horsepower rating	40,000 (13,300)
Total horsepower	173,300
Rated head (ft.) (cfs)	67(28,000)
Normal operating head (ft.) (cfs)	77(15,000)
Water depth @ intake (ft.)	75
Average annual energy (kwh)	657,000,000
After rediversion	129,000,000

*Pinopolis Powerhouse has 4 units of equal size (2 fixed-blade and 2 adjustable-blade) and 1 unit of smaller size (adjustable-blade). Provision is made for future addition of 1 unit.

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

INTRODUCTION

1. Authorization. The Cooper River Rediversion Project, which will reduce shoaling and restore the historic saline regimen to the Cooper River and Charleston Harbor, was authorized by the River and Harbor Act of 1968 (Public Law 90-483, 90th Congress, S. 3710, August 13, 1968). Section 101 of the 1968 Act is quoted in part as follows:

> "...That the following works of improvement of rivers and harbors and other waterways for navigation, flood control, and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and supervision of the Chief of Engineers, in accordance with the plans and subject to the conditions recommended by the Chief of Engineers in the respective reports hereinafter designated ... Cooper River, Charleston Harbor, South Carolina: Senate Document Numbered 88, Ninetieth Congress, at an estimated cost of $35,381,000 ...."

2. Purpose. The purpose of this design memorandum is to present information describing the effects of the project on the Jefferies Steam Plant and Jefferies Hydro Plant and a proposed cooling water scheme, including costs, justification, and design criteria, which will provide the Public Service Authority with equal operating capability after rediversion as it now enjoys. This design memorandum will form the basis for final design and plans and specifications for construction of the cooling water facilities for the Jefferies Steam Plant.

3. Scope. This memorandum provides detailed studies and proposed solutions to problems created when flows through the existing Jefferies Hydro Plant are restricted to a weekly average of 3,000 cfs. The method presented to cool the condenser discharge water from the Jefferies Steam Plant is a combination of additional flow release through the Jefferies Hydro Plant and the construction of a mechanical draft cooling tower.

4. Location. The proposed cooling water tower will be constructed adjacent to the Jefferies Steam Plant on property owned by the South Carolina Public Service Authority. This is located about 1 mile north of Moncks Corner, South Carolina, on the south side of Lake Moultrie. See plate 1.

STATEMENT OF PROBLEM

5. The Jefferies Steam Plant presently extracts condenser cooling water from the tailrace of the Jefferies Hydroelectric Plant. This is a once-through cooling system which discharges heated water back into the tailrace canal. Due to the Cooper River Rediversion Project, the present average flow of 15,600 cfs through the tailrace canal will be reduced to a weekly average flow of 3,000 cfs ± 5 percent. As a result of this significant flow decrease, continued operation of Jefferies Steam Plant utilizing the once-through condenser cooling system would result in unacceptable water temperature levels in the tailrace canal according to standards established by the South Carolina Department of Health and Environmental Control.

PRESENT ABILITIES AND CONSTRAINTS

6. Jefferies hydro plant, also known at the Pinopolis Hydro Plant, was completed as part of the original Santee-Cooper Hydro Project in 1942. Six generating bays were constructed and numbered sequentially from west to east. Jefferies Hydro Plant presently has hydraulic turbine units in all bays except number 5. Rated power generation capacity of the facility is 132.6 mW. Water supply for generation comes from Lake Marion and Lake Moultrie. The effective storage capacity in the two lakes available for hydrogeneration is 1,110,000 acre-feet for Lake Marion, and 760,000 acre-feet for Lake Moultrie. The combined hydro units have a maximum discharge capacity of approximately 27,500 cfs. Hydro releases are discharged directly to the tailrace canal immediately upstream of the Jefferies Steam Plant. Adequate water is currently available to meet cooling needs at Jefferies Steam Plant, subject to adjustment in power generation rates versus tailrace flow rates required by the State of South Carolina (DHEC) permit as described in paragraph 12.

7. Jefferies steam plant consists of four steam electric generating units. Units 1 and 2 were placed in commercial operation in 1953. These units have a rated capacity (gross) of 50 mW each. They were originally coal-fired units, but have since been converted to oil firing. Condenser cooling water for units 1 and 2 is supplied directly from the tailrace canal by two 49,000 gpm pumps. The heated water discharges through a tunnel system directly into the tailrace canal.

8. Units 3 and 4 were placed in commercial operation in 1969 and 1970, respectively. They are coal-fired units with a rated capacity (gross) of 177.5 mW each. Condenser cooling water for units 3 and 4 is supplied directly from the tailrace canal by three 53,000 gpm pumps. The heated water is discharged into a tunnel where it is combined with the discharge from units 1 and 2 in a common tunnel prior to emptying into the tailrace canal approximately 1/4-mile downstream from the Jefferies Hydro Plant.

9. Units 1 and 2 are presently used when power demands cannot be met by other facilities within the Authority's generating system, to provide emergency power during station outages within the system, and to meet demands of other electric systems in the power pool such as Duke Power, Carolina Power and Light, and South Carolina Electric and Gas. These units are also utilized when either unit 3 or 4 is down for scheduled maintenance. Units 1 and 2 may also be brought on line to exercise equipment and to confirm their ready operational status.

10. Units 3 and 4 are generally utilized in a most efficient manner consistent with power requirements and in conjunction with available hydro capacity; they are essentially base loaded and have relatively high load factors.

THERMAL DISCHARGE REGULATIONS

11. The 1970 Pollution Control Act of South Carolina, Section III, Paragraph 10, sets certain temperature limits on the waters of the tailrace canal downstream of the Jefferies Steam Plant discharge. These limits are set forth as follows:

> "All freshwaters of the State other than the upper Piedmont waters shall not exceed a temperature of 90° F at any time, after adequate mixing of heated and normal waters as a result of heated liquids, nor shall the water temperatures after passing through an adequate zone for mixing be more than 5°F greater than that of water unaffected by the heated discharge."

12. The South Carolina Department of Health and Environmental Control (DHEC) is the State agency charged with licensing and enforcement to maintain water quality standards. For ease of monitoring and enforcement, DHEC has done away with a defined mixing zone at Jefferies Steam Plant in favor of an end-of-pipe criteria based on the results of thermal discharge studies in the tailrace canal. Accordingly, the authorization to discharge under the National Pollutant Discharge Elimination System issued for Jefferies Steam Plant for a 5-year period beginning 19 June 1976, contains the following wording:

> "The South Carolina Department of Health and Environmental Control in light of the report "Evaluation of Thermal Discharges at Jefferies Steam Plant" submitted by the South Carolina Public Service Authorty and compiled by Enwright Associates, incorporates as part of this permit the following requirements pertaining to the thermal component of the discharge. These requirements will assure compliance with all State/Federal water quality standards.
>
> a. The discharge from the hydroelectric facility at the Pinopolis Dam and the megawatt production rate at the Jefferies Steam Plant shall be operated in such a manner that the ratio of the "discharge from the hydro" to the "megawatt production" is equal to or greater than 25.86 (see Note).
>
> Q = R(MW)
> Q = flow in cfs from the hydroelectric facility
> R = 25.86
> NOTE: Only when the background temperature is less than 85°F
> MW = megawatt production rate at the Jefferies Steam Plant
>
> Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Flow shall be monitored at plant intake. The background temperature is to be monitored consistent with that described in the report "Evaluation of Thermal Discharges at Jefferies Steam Plant," Exhibit J. Discharge temperature shall be monitored at the point of discharge prior to mixing with the receiving stream.

If the background temperature is greater than or equal to 85°F, then the discharge from the hydro shall be a function of the megawatt production rate and the background temperature in accordance with the following relationship:

$$Q = \frac{T_B}{252} MW$$

Where T_B background temperature in °F

b. Hydro Unit(s) Utilization

a. If $Q \leq 7{,}500$ cfs, then hydro unit(s) 1 or 1 and 2 shall be utilized.

b. If 7,500 cfs $< Q \leq 12{,}000$ cfs, then any combination of hydro units 1, 2, and 3 shall be utilized.

c. If $Q > 12{,}000$ cfs, then there shall be no requirements on which hydro units are to be utilized."

13. The reason hydro units 1, 2, and 3 (located on the opposite side of the tailrace) are specified for use is to prevent formation of eddy currents which would circulate the heated discharge plume upstream to the intake structure resulting in a form of "short circuiting."

14. Monitoring of background and discharge temperatures is by continuous recorder. Discharge flows are determined from circulating pump logs. Hydro releases and steam plant generation are determined from production charts.

BETTERMENTS

15. Present and post-rediversion compliance with the thermal discharge permit therefore becomes a simple matter of proportioning hydro generation releases with steam plant generation according to the formulas established. Review of plant operating records, the so-called "Enwright Report," regulations, discharge permits, and interviews with DHEC personnel confirm that present operation of Jefferies Steam Plant is in compliance with established thermal discharge standards. Therefore, the Government will not be awarding a betterment in providing a cooling system which complies with permit requirements.

FUTURE ABILITIES AND CONSTRAINTS

16. The reduction in tailrace flows following the rediversion project will have obvious implications on the operation of Jefferies Steam Plant. The contractural agreement between the Government and the Public Service Authority includes the following:

Release from Jefferies hydro during each week (defined as the period from the beginning of Saturday to the end of Friday) an average discharge of 3,000 cfs, ± 5 percent as a permitted operational variance, but not to exceed during any day (defined as midnight to midnight) an average of 5,000

cfs, + 5 percent as a permitted operational variance. Any sustained period of no discharge from Jefferies Hydro will be restricted to no longer than 70 consecutive hours, whether such a period is entirely within a single week or extends from 1 week into the next. In addition, any period of 3 consecutive days with average discharges under 1,000 cfs must be followed with at least 2 consecutive days with average discharges of at least 4,000 cfs each.

17. The Authority may continue to generate and discharge any amount of water up to full hydro capacity at any time so long as they observe the above tailrace restrictions. However, without supplementary evaporative cooling, the Jefferies Steam Plant long-term generation rate will be limited by the thermal discharge permit to that allowable in conjunction with a hydro discharge release of 3,000 cfs maximum weekly average and 5,000 cfs maximum daily average. By formula, this converts to only 116 mW and 193 mW, respectively. By coincidence, Units 1 and 2 have a combined gross capacity of only 98 mW.

COOLING FOR UNITS 1 AND 2

18. Since units 1 and 2 have a combined cooling water requirement of approximately 2,500 cfs, it was orginally thought that the average allowable flow of 3,000 cfs would be adequate to continue to provide once through cooling for these units. However, a closer reivew indicated that this alternative would severely restrict the Public Service Authority's ability to use the additional 84 mW of capacity which is installed in their system as part of the rediversion project.

19. Studies were made, as discussed in paragraphs 20 through 23, to determine whether it is to the Government's advantage to allow additional releases through the Jefferies Hydro Plant to cool units 1 and 2 or to provide structural facilities for that purpose. A cooling tower was used for comparative purposes since this is the recommended scheme for cooling units 3 and 4.

20. WES furnished data concerning the effects of additional flow releases. This information is contained in exhibit A. Figure 19 of the exhibit illustrates the range of shoaling expected to occur in Charleston Harbor as a function of Pinopolis' weekly average releases. Two procedures were used. Tables 1 and 2 detail net annual costs computed using both procedures. The net cost is the excess dredging cost less the energy credit savings to the Government resulting from passing more water through Pinopolis. Table 3 is an average of these two procedures. The disparity between shoaling rates shown on page 7 of exhibit A and those shown in the tables is due to differences in procedures used to compute average flow from percentage of time cooling releases are made. Data shown in the tables are consistent with figure 19 of exhibit A.

21. The annualized cost of a cooling tower to cool units 1 and 2 was computed assuming that the units would be used for different percentages of time. This annual cost is based on an estimated first cost of $4,475,000 amortized at 3-1/4 percent for 50 years. Present day operation and maintenance costs were also considered. It should be noted that the operation cost increases with the amount of time that units 1 and 2 are used.

22. A graph has been developed which shows the annual cost of both alternatives plotted against the amount of time units 1 and 2 are on line. Procedure 1 for determining the dredging costs was used since it is the most conservative of the two procedures. This graph is shown as figure 1. You will note from the graph that it is cheaper for the Government to allow additional flows for uses of the units up to 12.2 percent. From that point on, it becomes cheaper to construct the cooling tower.

23. Based on the results of these studies and for the following reasons, the conclusion was reached that, for the present, it is in the best interest of the Government to allow additional flows through the Jefferies Hydro Plant as the best means to cool units 1 and 2.

a. These units presently operate approximately 10 percent of the time on an essentially independent cooling system from units 3 and 4.

b. These units are more than 28 years old and are not as efficient as units 3 and 4.

c. The units are oil fired and fuel costs are likely to continue escalating making them even less economical to operate.

d. A review of plant operating records indicates units 1 and 2 are used primarily for backup and emergency service.

e. The South Carolina Public Service Authority has a new steam plant under construction at Cross, South Carolina, which is scheduled to begin commercial operation in November 1983.

TABLE 1

$$\text{Power Benefit} = (42806)\left(\frac{4.9-3.7}{4.9}\right)(Q-3000)(0.0622)$$

% of Time Cooling Releases Passed	Average Annual Flow, Q (cfs)	*Annual Excess Dredging (yd^3)	Unit Cost	Excess Dredging Cost	Excess Power Benefit Over 3,000 cfs	Net Total Annual Cost
0	3,000	0	$1.40	$ 0	$ 0	$ 0
10	3,223	300,000	1.40	420,000	145,407	274,593
20	3,446	700,000	1.40	980,000	290,814	689,186
30	3,670	1,000,000	1.40	1,400,000	436,873	963,127
40	3,893	1,300,000	1.40	1,820,000	582,280	1,237,720
50	4,116	2,000,000	1.40	2,800,000	727,687	2,072,313
60	4,339	3,000,000	1.40	4,200,000	873,094	3,326,906
70	4,562	3,900,000	1.40	5,460,000	1,018,500	4,441,500
80	4,786	5,100,000	1.40	7,140,000	1,164,559	5,975,441
90	5,009	6,200,000	1.40	8,680,000	1,309,966	7,370,034
100	5,232	6,300,000	1,40	8,820,000	1,455,373	7,364,627

*Dredging in excess of that required with an average flow from Pinopolis of 3,000 cfs.

PROCEDURE 1

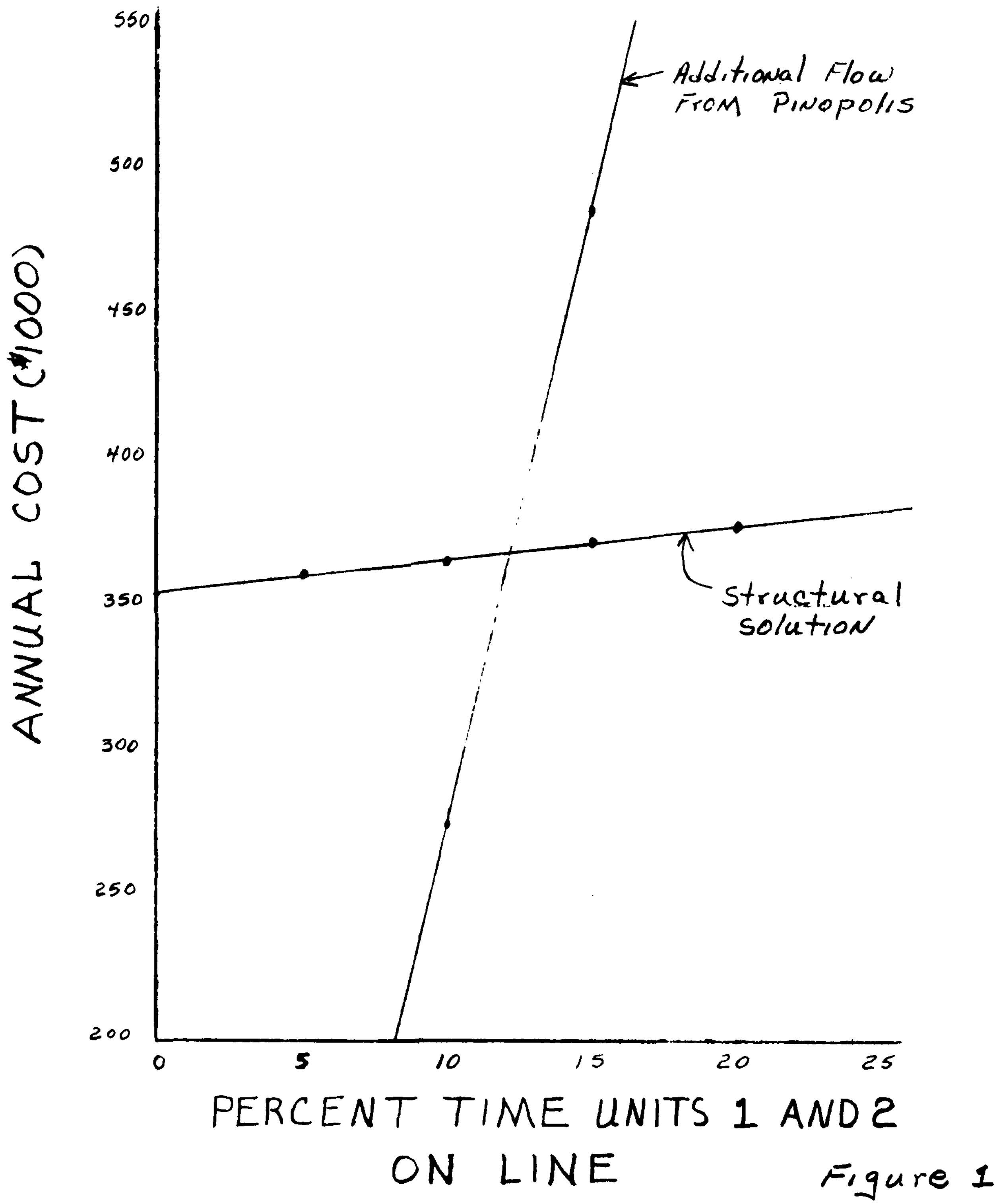
TABLE 2

Power Benefit = (42806) $\left(\frac{4.9-3.7}{4.9}\right)$ (Q-3000) (0.0622)

% of Time Cooling Releases Passed	Average Annual Flow, Q (cfs)	*Annual Excess Dredging (yd^3)	Unit Cost	Excess Dredging Cost	Excess Power Benefit Over 3,000 cfs	Net Total Annual Cost
0	3,000	0	$1.40	$ 0	$ 0	$ 0
10	3,223	100,000	1.40	140,000	145,407	- 5,407
20	3,446	200,000	1.40	280,000	290,814	- 10,814
30	3,670	300,000	1.40	420,000	436,873	- 16,873
40	3,893	390,000	1.40	546,000	582,280	- 36,280
50	4,116	850,000	1.40	1,190,000	727,687	462,313
60	4,339	1,800,000	1.40	2,520,000	873,094	1,646,906
70	4,562	2,600,000	1.40	3,640,000	1,018,500	2,621,500
80	4,786	3,400,000	1.40	4,760,000	1,164,559	3,595,441
90	5,009	4,200,000	1.40	5,880,000	1,309,966	4,570,034
100	5,232	4,300,000	1,40	6,020,000	1,455,373	4,564,627

*Dredging in excess of that required with an average flow from Pinopolis of 3,000 cfs.

PROCEDURE 2



Additional Flow From Pinopolis
Structural solution
ANNUAL COST ($1000)
550
500
450
400
350
300
250
200
0
5
10
15
20
25
PERCENT TIME UNITS 1 AND 2 ON LINE

Figure 1

COOLING WATER ALTERNATIVES CONSIDERED AND REJECTED FOR UNITS 3 AND 4

24. General. Several methods of providing cooling water to units 3 and 4 were considered and rejected without detailed economic and functional analysis. These alternatives, both once-through and closed loop types, were rejected for various basic traits that made them unsuitable for application at Jefferies Steam Plant.

25. Alternative 1. A two-stage spray pond which operates as a once-through system, discharging to the tailrace canal was considered. Water would be pumped by the existing circulation pumps through the condensers and into a new pumping station from which it would be transferred through piping underneath the tailrace canal to two cooling water ponds arranged in series. The first pond would be equipped with vertical spray nozzles designed to handle full condenser water flow. The pond discharge system would be arranged to allow discharge directly to the tailrace or diversion of 30 percent of the flow through pond No. 2 which would also have spray nozzles and would provide additional cooling as required. A 10-degree approach to wet bulb temperature is necessary for economical operation of the turbine generators. Any increased approach would result in higher turbine exhaust pressures and reduce turbine efficiency as further discussed in a later section. With a spray pond system, the 10-degree approach cannot be reliably obtained as it is dependent upon topography, surrounding trees, and variable wind conditions. However, the primary drawback to this system and any evaporative cooling system which discharges to the tailrace canal is that during winter and early spring months, wet bulb temperature may be up to 12°F higher than tailrace water temperature, as shown in table 3, and would be only a maximum of 7°F below condenser discharge temperature. When this occurs, the water may receive little or no cooling from the spray system and would be returned to the tailrace canal at temperatures in excess of allowable thermal limits. In other words, this system during certain periods of the year would be operating in an identical fashion as the current once-through system and would, therefore, be of no benefit.

TABLE 3
SEASONAL TEMPERATURE DATA

Month	Tailrace* Background Temperature Minimum	Average	Maximum	Wet Bulb** Temperature	Dry Bulb** Temperature
January	39°F	43°F	53°F	49.1°F	57.4°F
February	39	43	50	50.7	59.8
March	50	58	65	54.3	64.9
April	65	69	74	61.2	73.3
May	71	74	77	68.0	80.3
June	75	81	85	73.7	84.9
July	84	86	89	76.1	85.8
August	83	84	85	75.8	85.9
September	80	83	88	72.2	81.7
October	63	70	80	63.8	74.2
November	59	63	67	56.1	66.0
December	47	53	60	49.2	57.6

* Recorded data furnished by South Carolina Public Service Authority for 1977.

** From "Revised Uniform Summary of Surface Weather Observations, Charleston, S.C.," Data Processing Division, ETAC, USAF, Air Weather Service (MATS), Readings from 2:00-4:00 P.M.

26. Alternative 2. A similar two-stage spray pond system utilizing Ingersoll Rand Spray Trees in lieu of the spray nozzle system of Alternative 1 was considered. This would also discharge back to the tailrace canal and has been rejected for the same reasons as Alternative 1; primarily due to the fact that it would be of no benefit during certain times of the year.

27. Alternative 3. A once-through system was considered using spray equipment wherein the spray nozzles would be located in the tailrace canal downstream from the intake structure. The discharge from the nozzles would fall directly into the canal. This also was rejected for the same reasons as Alternative 1. In addition, it would require the construction of a navigation safety barrier around the spray area.

28. Alternative 4. Another once-through system was considered which does not rely on evaporative spray cooling. This scheme calls for the hot water from the condenser to be discharged through an extended pipe with multiple exit ports spaced under water down the length of the tailrace canal. This would diffuse the heated flow gradually into the tailrace canal using the increased volume of water to absorb and dissipate the heat. The post-redivision contract between the Government and the Authority allows periods of up to 70 hours with zero flow in the tailrace canal. In order for the volume of the canal to absorb the heat from the condenser discharge without exceeding thermal limits permitted by DHEC, the discharge pipe would have to be 12 miles long. In addition, should the ambient water temperature be greater than 85°F which does occur during the summer months of June through September, the discharge could heat the tailrace canal above 90°F.

29. Alternative 5. Natural draft cooling towers were considered for use in a closed loop cooling system which would avoid the problems of discharge to the tailrace canal. The primary advantage of a natural draft cooling tower is that no fans are required which results in substantial power savings. However, these savings would not offset the high initial cost which would be approximately 2-3 times the cost of a mechanical draft tower. Natural draft cooling towers are economically feasible only in much larger utility applications, particularly in areas with weather conditions such as Berkely County, South Carolina.

30. Alternative 6. Also considered as a closed loop system was construction of a cooling pond without spray equipment. This passive system would rely on surface evaporation for cooling of the water. Preliminary calculations indicate that the maximum heat transfer would be 2 - 4 BTU/hr - ft^2 - °F. During high summer conditions with high wet bulb temperatures, and solar radiation offsetting part of the evaporative cooling, it is estimated that a pond capable of cooling Units 3 and 4 would require approximately 1,000 to 1,500 acres of surface area. The extensive land area required would be prohibitive to the feasibility of this system. In addition, this type of system could not provide a reliable approach to wet bulb temperature and would create a corresponding decrease in steam plant efficiency.

31. Alternative 7. Use of an air-cooled condenser for the generator exhaust would be independent of tailrace conditions or wet bulb temperatures. In this system, no cooling water would be used. This type of application is generally feasible only in areas of the country with severe water shortages. Since no evaporative cooling is involved, the effectiveness is dependent on ambient air dry bulb temperature, rather than wet bulb temperature. The higher dry bulb temperature coupled with a greater difference between steam saturation temperature and cooling air temperature would result in a substantially higher turbine back pressure and very poor turbine efficiency. In addition, the increased back pressure may exceed the safe operating limits for the turbines.

32. Alternative 8. Practical use of the heated water discharge from the condensers on a once-through basis for agricultural purposes such as soil heating or spraying of vegetation for temperature control in very hot or very cold weather would be feasible only in areas with extensive agricultural development in the immediate vicinity of the plant. The piping cost involved to distribute and utilize the large quantity of water would be prohibitive.

ALTERNATIVES SUBJECTED TO IN-DEPTH EVALUATION

33. General. Based on preliminary investigation, three closed-loop cooling water schemes were selected as being feasible. A comparative life cycle cost analysis was performed on each of these Alternatives. Parameters used in the analysis are presented in Table 4.

TABLE 4

LIFE CYCLE ANALYSIS PARAMETERS

Units No. 3 & 4 Capacity (net)	330 mW
Cooling Water Flow	159,000 GPM
Maximum Condenser Heat Load	1.44 X 10^9 BTU/HR
Boiler Efficiency	88.3%
Turbine Heat Rate correction Factors	Per G.E. Curves
Design Wet Bulb Temperature	79°F
Cooling Water Booster Pump Efficiency	86%
Pump Motor Efficiency	93%
Fan Motor Efficiency	91.5%
Fuel Cost	$\$1.59/10^6$ BTU
Electric Energy Cost	16.10 MILS/kWh
Capacity Charge	$98.50/kW
Life Cycle Duration	50 Years
Discount Rate	3-1/4%
Fuel Inflation Rate	5%
Electric Demand and Energy Inflation Rate	7%
Annual Fixed Cost	9.17%

34. Alternative 9. A mechanical draft cooling tower would function as part of a closed loop cooling system. Hot water discharge from the condensers would be diverted to a new pump station which would lift the water over the cooling tower. The cooled water would drain from the cooling tower basin by gravity to the existing pump station inlet where it would be returned to the condensers for units 3 and 4. All tie-ins to the piping system and blanking of the existing system would be made with motor-operated valves, thereby allowing the plant to return to a once-through cooling system in event of emergency. The advantages of the mechanical draft tower are that it is proven technology, a 10°F approach to wet bulb temperature is considered reliable as the tower is not dependent upon wind conditions, and the tower would occupy a reasonable land space. The tower could be located on the same side of the tail-race canal and would not require a river crossing. The closed loop cooling system would make units 3 and 4 totally independent of future hydro discharge rates. The primary disadvantage of the mechanical draft tower is the power required to pump the water up to the tower inlet, as well as power required to operate the fans during periods of the year with high ambient wet bulb temperatures. Cold water temperature to the condensers during part of the year would be higher than is presently achieved with the once-through system resulting in some loss of turbine efficiency. This would be offset, however, by the ability of the tower to control minimum cold-water temperature. Heat rate curves for the present units indicate that excessively low-water temperature as occurs in the tailrace during winter months also results in a reduction in turbine efficiency. These curves are presented in exhibit B.

35. Alternative 10. The second system evaluated involves using Lake Moultrie as a heat sink for discharge of the condenser hot water. The cooling water would be drawn from the tailrace canal and pumped through the condensers using the existing facilities. A new pump station would be constructed which would lift the water over the dam and into the lake discharging through a diffuser pipe on the lake bottom. The diffuser discharge would be far enough away from

the hydro plant to prevent any significant recirculation. Because the same tail-race water is used for cooling as the existing system, there would be no change in turbine efficiency due to higher back pressure. The power required to pump the water from the condenser discharge up to the lake elevation would be partially recovered by eventual return of the water through the hydro plant. In addition, storage of the returned water would enhance peaking potential of the hydro plant. This scheme would involve a minimal land requirement. The primary disadvantage of the pump-back alternative is that it would introduce a thermal plume into Lake Moultrie. The enviromental effects of this thermal plume would have to be assessed for support of an applicant for permit approval by the South Carolina Department of Health and Environmental Control. Initial analysis of the plume at a variety of ambient water temperature conditions ranging from 70°F to the recorded high of 88°F indicate that the isotherm which is 2°F above ambient lake temperatures will be restricted to within 100 to 200 feet of the diffuser pipe. The slightly warmer water would then radiate outward as a thin surface film for approximately another 1,000 feet before reaching ambient levels. Thus the lake has the ability to absorb the heated discharge in a relatively small, confined area which would likely have minimal environmental consequences. This approach would require further modeling and analysis of the thermal plume and aquatic systems in the lake prior to approval by DHEC and the Department of Wildlife and Marine Resources. The primary consideration would likely be the effect of the thermal plume on the lake's striped bass population. It is also a strong possibility that the final Cooper River Rediversion Project Environmental Impact Statement may require revision. Considerable time would be involved for further analysis and permit approval with the distinct possibility of eventual rejection for environmental reasons. At that time, it would not be possible to switch to one of the other alternatives wihtout drastic impact on the entire project schedule, possibly delaying start-up by 1 to 2 years.

36. Alternative 11. The third system evaluated on a comparative basis is a spray canal. Unlike the spray systems discussed earlier, this would be a closed-loop configuration returning water from the canal discharge back to the condenser inlets. The existing condenser discharge would flow into a new pump station, which would transfer water under the tail-race canal into a spray canal. The spray canal would contain from 50 to 100 spray module assemblies depending on the manufacturer. These spray modules lift the water out of the canal up into a spray cone from which it falls back into the canal. This process results in decreasing water temperature as the water travels down the canal from spray module to spray module. The canal discharge would flow by gravity through traveling screens, then back under the tailrace to the existing pump suction. The spray canal has been chosen as an example of spray system alternatives because it represents new technology. It has dominated over spray trees or flat-bed spray ponds in most recent spray system installations. Because of the greater number of spray module segments involved, the spray canal has greater flexibility for reducing power consumption in cold weather by shutting off any number of modules. It is not necessary to shut down any significant portion of the system for spray module maintenance, only the module involved. A further advantage is that the large water volume imponded in the canal provides a fly-wheel effect for carrying the system through relatively short daily periods of high wet bulb temperature. Disadvantages of the spray canal system include the fact that it is dependent on surrounding terrain and wind for approach to wet bulb temperature resulting in lower system reliability and possible loss in turbine efficiency. The canal which would be 8,100 feet long

and 300 feet wide requires considerable land space and therefore must be located across the tailrace canal necessitating a river crossing for water supply and return. Access to the canal area would require construction of a new road and because of the soil conditions, an impervious liner would be required for the canal. The larger volume of water impounded would require a greater quantity of chemicals for water treatment than Alternative 9.

CONCEPTUAL COST ESTIMATES

37. Cost estimates were prepared for alternatives 9, 10, and 11, based on a single-line design schematics and equipment locations agreed upon with the South Carolina Public Safety Authority. These schematics and location sketches are presented in exhibit C. The estimates for each alternative are for the purpose of conceptual planning and comparative determination of the most cost-effective alternative. The estimates have been built up from budget pricing on major pieces of equipment and estimate construction quantities. Costs are based on competitive bidding at present day prices. Each of the project estimates includes allowances for contingencies and estimated design engineering costs. The estimates do not include resident engineer's supervision, financing costs, or Corps of Engineers legal and administration costs. The total comparative cost estimates are as follows:

Alternative 9 - Mechanical Draft Cooling Tower	- $ 9,200,000
Alternative 10 - Pumpback to Lake Moultrie	- 4,950,000
Alternative 11 - Spray Canal System	- 13,650,000

Tables 5, 6, and 7 present a breakdown of estimated costs for the individual systems.

TABLE 5

CONCEPTUAL COST ESTIMATE
MECHANICAL DRAFT COOLING TOWER
(March 1980 Price Levels)

ITEM	COST
Booster Pump Station Influent Piping	$ 350,000
Booster Pump Station	700,000
Pump Discharge and Gravity Return Pipes	2,300,000
Cooling Towers	2,800,000
Control Valves	450,000
Electrical	350,000
Subtotal	$6,950,000
Contingencies, 15%	1,050,000
Estimated Contract Cost	8,000,000
Engineering and Design, 8.5%	700,000
Supervision and Administration, 6%	500,000
Estimated Total Cost	$9,200,000

TABLE 6

CONCEPTUAL COST ESTIMATE
PUMP-BACK TO LAKE MOULTRIE
(March 1980 Price Levels)

ITEM	COST
Booster Pump Station Influent Piping	$ 350,000
Booster Pump Station	800,000
Pump Discharge Pipe	2,450,000
Control Valves	100,000
Electrical	100,000
Subtotal	$3,800,000
Contingencies, 15%	550,000
Estimated Contract Cost	4,350,000
Engineering and Design, 8.5%	350,000
Supervision and Administration, 6%	250,000
Estimated Total Cost	$4,950,000

TABLE 7

CONCEPTUAL COST ESTIMATE
SPRAY CANAL SYSTEM
(March 1980 Price Levels)

ITEM	COST
Booster Pump Station Influent Piping	$ 350,000
Booster Pump Station	450,000
Pump Discharge and Gravity Return Pipes	2,550,000
Spray Canal and Equipment	5,900,000
Control Valves	450,000
Electrical	700,000
Subtotal	$10,400,000
Contingencies, 15%	1,550,000
Estimated Contract Cost	$11,950,000
Engineering and Design, 8.5%	1,000,000
Supervision and Administration, 6%	700,000
Estimated Total Cost	$13,650,000

LIFE CYCLE COST ANALYSIS

38. Because each of the alternatives has significantly different operating and maintenance costs, a life-cycle cost analysis was performed for each. This analysis provides a life-cycle cost comparison at interest rate of 3-1/4 percent for 50 years, including operation and maitenance cost. Operational costs were

based on power values obtained from the Federal Power commission. These power values were an update of those used in the contract between the Government and the South Carolina Public Service Authority. Power costs for each alternative were estimated taking into consideration:

a. Jefferies Steam Plant Units Number 3 and 4 load factor.

b. Period of time Jefferies Steam Plant Units Number 3 and 4 are on line.

c. Percentage of time Jefferies Hydro Plant discharges adequate water to allow once-through coolig in the steam plant units.

d. Ambient wet bulb temperature.

39. Since circulating water returned to Lake Moultrie will alow additional discharge from the hydro by an approximately equal amount, some energy can be reclaimed. Credit was given to the pump-back method for reclaimed energy in estimating operating costs. The contract between the Government and the Authority states that Jefferies Hydro produces 4.9 net kW per cfs. Recovered energy was discounted by a small percentage to account for recirculated water that will be lost by evaporation, flow over Wilson Dam, and through the navigation lock. Based on the above criteria, the following life-cycle annual costs were developed:

Alternative 9	- Mechanical Draft Cooling Tower	- $1,038,000
Alternative 10	- Pumpback to Lake Moultrie	- 876,000
Alternative 11	- Spray Canal	- 1,200,000

A breakdown of these life-cycle costs is given in tables 8, 9, and 10.

40. Although the pump-back alternative has the lowest initial capital cost and the lowest annual life-cycle cost, there were serious concerns as to whether this alternative could ever be implemented. On 20 November 1978, a meeting was held with South Carolina Wildlife and Marine Resources Department, and the South Carolina Department of Health and Environmental Control to discuss the three alternatives. It was clearly the feeling of the State agencies as indicated in exhibit D that the pump-back scheme was the least desirable. Before proceeding with this scheme, a 1-year biological study, normally termed a 316a variance study, would have to be performed. Even after this study is concluded, there can be no certainty of final approval by the permitting authorities. The pump-back system would also require extensive monitoring of the affected lake system both before and after the discharge begins in order to verify or disprove any projected impacts. It is also noted that similar considerations influenced the Authority to forego a lake cooling option for their Cross Steam Electric Station to be completed in 1983 on the Santee Cooper lakes.

41. Correspondence from these two agencies is contained in exhibit D. It will be noted that the pumpback is considered to be especially undesirable because the discharge point is in the path of migrating species of aquatic organisms entering Lake Moultrie from the Cooper River. The Pinopolis Dam area is also one of the best areas in the lake for striped bass fishing. Therefore, the discharge point may well have to be moved to a location further from the powerhouse. This location would be determined by a thermal plume model study. The

cost of this scheme would be more comparable to that of the cooling tower as a result of extending the discharge pipe.

42. Due to the problems discussed in the foregoing and uncertainties of obtaining approval and permitting from other agencies, the pump-back plan was abandoned. It can also be reasoned that the process of variance study and permitting, even if successful, would invite adverse public reactions and impact project completion. Based on the life-cycle comparison between the mechanical draft cooling tower and the spray canal system, the cooling tower was selected as the proposed method of providing cooling for units 3 and 4.

TABLE 8

LIFE CYCLE OPERATION AND MAINTENANCE COSTS
Mechanical Draft Cooling Tower

Operation Costs		
Energy Use		
Cooling Tower Fans	$ 60,000	
Cooling Water Booster Pumps	215,000	
Demand Charge		
Cooling	120,000	
Cooling Water Booster Pumps	215,000	
		$ 610,000
Maintenance Costs		
Pumps and Motors	$ 14,000	
Cooling Tower	73,000	
Piping and Valves	11,000	
Wiring, Conduit, and Transformers	7,000	
Replacement of Equipment	40,000	
		$ 145,000
Amortization		283,000
TOTAL ANNUAL LIFE CYCLE COST		$1,038,000

TABLE 9

LIFE CYCLE OPERATION AND MAINTENANCE COSTS
Pumpback to Lake Moultrie

Operation Costs		
Energy Use		
Cooling Water Booster Pumps	275,000	
Demand Charge		
Cooling Water Booster Pumps	395,000	
		$ 670,000
Maintenance Costs		
Pumps and Motors	$ 15,000	
Piping and Valves	11,000	
Wiring, Conduit, and Transformers	3,000	
Replacement of Equipment	22,000	
		$ 51,000
Amortization		155,000
TOTAL ANNUAL LIFE CYCLE COST		$ 876,000

TABLE 10

LIFE CYCLE OPERATION AND MAINTENANCE COSTS
Spray Canal

Operation Costs		
Energy Use		
Cooling Water Booster Pumps	$ 45,000	
Spray Modules	135,000	
Demand Charge		
Cooling Water Booster Pumps	45,000	
Spray Modules	315,000	
		$ 540,000
Maintenance Costs		
Pumps and Motors	$ 11,000	
Spray Canal and Modules	132,000	
Piping and Valves External to Spray Canal	13,000	
Wiring, Conduit, Transformers, and Switchgear	19,000	
Replacement of Equipment	65,000	
		$ 240,000
Amortization		420,000
TOTAL ANNUAL LIFE CYCLE COST		$1,200,000

DESCRIPTION OF SELECTED COOLING WATER SYSTEM

41. Cooling Tower. The cooling tower has been sized for the following design conditions.

159,000 gpm
19°F Temperature Range
10°F Approach Temperature
79°F Wet Bulb Temperature

The arrangement of the cooling tower and piping is shown on Plates 2 and 3. A schematic of the mechanical draft cooling tower system is shown on plate 4.

42. The water flow rate has been set by the capacity of the existing circulation pumps which will be an integral part of the system. This fixed capacity in conjunction with the fixed maximum heat of rejection in the surface condenser results in a cooling water temperature rise through the condenser and temperature drop through the cooling tower of 19°F, which is specified as the cooling tower range. A 79°F wet bulb temperature has been obtained from tower manufacturer's meteorological data as being the wet bulb temperature for Charleston, South Carolina, which is equalled or exceeded 5 percent of the time on the average during the warmest consecutive 4 months, as determined by the mean wet bulb temperature. The times that this design wet bulb temperature is exceeded would be in relatively short periods during the afternoon hours. The duration of peaks coupled with the fly-wheel effect of the water in the cooling system would result in a minimal impact on turbine performance.

43. A computerized optimization analysis has been utilized to select the 10°F approach temperature. This computer program balances the increased tower size and costs for a closer approach against the reduction in cold water temperature and turbine heat rate. It then establishes a life-cycle cost for each selected approach temperature. The program also evaluates the cost of parasite power required to operate the cooling water system and cooling tower fans. Input data includes first cost of equipment, fuel cost to the boiler, average boiler efficiency of cooling water pumps, cooling water pump motors, cooling tower fan motors, cooling tower fan horsepower and operatig hours, costs of electrical energy, demand or capacity charge, head loss through cooling water piping and cooling tower, and escalation factors for operating costs. Basic input also includes turbine heat rate and loading data based upon the turbine generator characteristics and load duration data for the unit. The cooling tower performance is evaluated based on seasonal average wet bulb temperatures. During winter months, cold water temperature leaving the cooling tower is limited to 60°F minimum to prevent icing and to optimize turbine heat rate. Approach temperatures were analyzed ranging from 8°F to 14°F in 2°F increments. Preliminary cooling tower selections were received from two manufacturers for each approach temperature. A single cooling tower manufacturer was selected to provide input data for analysis including cooling tower first costs, fan horsepower, and cooling water pump head. Cooling tower approach temperature was the only parameter varied in the analysis.

44. After extensive consideration, it was decided to use a 30-year life cycle for cooling tower optimization as opposed to the 50-year life used in alternative evaluation. This was based on the overpowering influence of power costs on

a 50-year tower life, the difficulties of accurate projection of energy costs, and realistic service life for steam units and tower structure.

45. Output information, including annual operating costs and life-cycle costs, are presented in exhibit E. The analysis shows a decreasing life-cycle cost for 14°F approach down to 10°F approach. The 8°F approach tower shows a virtually identical life-cycle cost to the 10°F approach tower indicating that at lower approach temperatures the life-cycle cost would rise. A plot of this information is included in exhibit E. An 8°F approach tower is not common in the industry and would be considerably larger than a 10°F tower. Also, the Authority's nearby Winyah Station is installig 10°F towers on new units. Therefore, the 10°F approach has been selected as the optimum for system design.

46. A further life-cycle cost analysis was run for comparison of the existing once-through cooling system utilizing the same turbine loading data and heat rate correction data. Cold water temperatures from the tailrace canal were input to the program rather than water return from a coolig tower. Because the cold water temperature from the tailrace is considerably below 60°F during substantial portions of the year, the turbine heat rate has actually been increased over the optimum during these periods. The analysis shows that turbine efficiencies are lower, and therefore fuel costs to the boiler are actually 0.1 percent greater for the existing once-through system than for the 10° approach cooling tower. Therefore, it may be concluded that the installation of a 10° approach cooling tower will result in no loss of turbine efficiency. The results of this analysis are included in exhibit E.

47. Other uses of cooling water such as turbine oil cooling and bearing cooling will be adequately served by the selected tower. The maximum annual cold water temperature from the tower of 89°F is equal to the present tailrace maximum water temperature of 89°F and should therefore have no adverse effect on performance of these auxiliaries.

48. Pump Station. The existing circulating water pumps will be an integral part of the new cooling tower system. Presently the pumps draw water from the tailrace canal, pump through the condenser, and discharge to the tailrace canal at the same elevation. In the new system, these pumps will take their suction from the cooling tower basin at approximately a 25-foot higher elevation. The pumps will discharge through the condenser to a new booster pump pit with a free surface elvation approximately the same as the tower basin. Therefore, although the pumps will operate under a 25-foot positive suction head, the net pumping head will remain the same. The new booster pumps will provide only the necessary head to overcome pipe friction and to lift the water over the cooling tower. Arrangement of the new pump station is shown on plate 5 and plate 8. Since the new pump capacity must exactly match the existing pump capacity, care must be taken to select new pumps with compatible operating curves. Performance tests must be run on the existing pumps to determine their actual operating characteristics. The new pumps will be vertical turbine pumps; each will have a rating of 53,000 gpm at approxiately 45 feet total dynamic head depending on requirements of the cooling tower selected. The pumps will have an efficiency at rating of approximately 82 percent, and each pump will be driven by a 750 HP, 450 rpm motor. Each new pump will be electrically interlocked with a corresponding existing pump to insure that at all times the system capacity is balanced. Design of the new pump pit is in conformance with Hydraulic Institute Standards.

A screen will be provided across the inlet to the pit, not for trash removal, but to stabilize the flow and promote equal distribution of flow to each pump. Normal pump submergence in the pit will be approiximately 15 feet. The discharges from the pumps will manifold together into a common 108-inch diameter pipe which will run underground to the new cooling tower. A 60-inch diameter overflow pipe is provided to direct any emergency spillage away from electrical gear to the tailrace canal.

49. Major Piping. Reinforced concrete cylinder pipe manufactured in accordance with American Water Works Association specification No. C-301 is recommended for major underground water piping. The concrete pipe has been selected for permanence of installation and low friction factor although cement lined steel pipe should be allowed as an option in the contract plans and specifications. Life- cycle cost for circulation pump power is estimated to be $235,000 for each foot of pumping head. Therefore, the selection of piping and cooling tower structure to minimize pumping head is very important. The major underground water pipes going to and from the cooling tower have been sized as 108-inch diameter. Although the velocity in these lines will be 5.57 feet per second, which is fairly low, the reduced head loss through the large diameter pipe is approximately 1.9 feet less than 96-inch diameter pipe and 5.7 feet less than 84-inch diameter pipe. This results in 30-year life cycle cost savings for pump power of $440,000 and $1,360,000, respectively. These savings are partially offset by increased life cycle pipe costs of $230,000 over 96-inch diameter pipe and $600,000 over 84-inch diameter pipe.

50. Cooling tower construction. The mechanical draft cooling tower in the scheme subjected to in-depth evaluation as "Alternative 9" was originally conceived as a pair of wood frame structures at a budget cost of $2,200,000. However, the subsequent decision to optimize tower design for a 30-year minimum service life precluded further consideration of wood towers, with the recommended alternative being a reinforced concrete structure with stainless steel fittings. The wood structural components would have a maximum expected service life of 10 to 25 years based on a good water treatment system and good maintenance. This would then require at least one and possibly two tower replacements during the 30-year service life. In addition to the direct cost of replacement, there would be a severe penalty in either lost generation at Jefferies Steam Plant during reconstruction or increased tailrace discharge to allow once through cooling with subsequent increased dredging costs of Charleston Harbor. The concrete structure on the other hand should last the entire 30 years. Cooling tower manufacturers have quoted price increases of 30 to 50 percent for concrete structure versus wood structure. The economics would therefore favor a concrete tower, even more so if a 50-year service life is considered. Fill material considered for both type towers would be PVC with the same service life in each situation. The cost for the cooling tower and basin given in the detailed cost estimate later in this memorandum includes more than the 30 to 50 percent additional cost of concrete versus wood. This price is conservative and is based on a tower which can accommodate either PVC fill or ceramic fill. This ceramic fill capability was not evaluated in the comparative cost analysis but is included in the detailed estimate to allow consideration in budgeting.

51. A single tower is preferable to a pair of smaller structures because two of the three circulating water pumps must operate even when one of the generating

units is out of service. The reduced flow rate would still require both towers to remain in service, eliminating any possible advantage of duplicity.

52. Tower fill material should be either PVC or ceramic tiles. Because PVC fill has been in use fewer than 10 years in this type of application, there is insufficient data to determine useful service life. Installed performance of PVC fill is usually guaranteed for only 2 years, after which freeze-thaw cycles and ultra-violet exposure began to slowly reduce efficiency. Industry sources agree that an expected life of 15 years is reasonable, allowing for good maintenance practices and some loss of efficiency. Ceramic tile fill is guaranteed for 25 years and can be expected to last beyond 30 years without replacement. However, the first cost of the larger, heavier ceramic fill tower is significantly higher, on the order of $1,250,000 more, than an comparable PVC fill tower. A recent estimate of cost provided by one manufacturer to replace PVC fill in this tower was $1,230,000.

53. It is planned to accept bids for both types of fill and selection made based on life-cycle cost of actual bid price and fill replacement cost estimates received.

54. Selection of a cross-flow versus counter-flow cooling tower will be left to the tower manufacturers. Manufacturers will optimize their tower selection on the basis of providing pumping power and fan horsepower cost comparison factors.

55. A soils investigation was performed at the site. Boring locations are indicated on plates 2 and 3. The soils report and boring logs are presented in exhibit H. Based on the investigation results and estimated loads for a concrete cooling tower, it is anticipated that 40-ton, 60-ton, and 90-ton minimum displacement piles will be installed approximately as shown on plate 9.

56. Basin. The cooling tower basin may be constructed approximately as shown on plate 9. The water flow arrangement in the basin will be such that individual cells can be shut down and isolated for removal of any sediment in the basin with a front-end loader. Access for the front-end loader will be provided into each cell. Cold water leaving each cell will flow over a full-lenth weir into a common return flume, through a trash screen to the gravity return pipe, and on to the existing pump inlets. Makeup water to replace losses for evaporation, drift, and cooling tower blowdown will be controlled by the level in the return flume. In order not to exceed design water flows through any one cell, one or two cells may be shut down during periods when either unit 3 or 4 is offline and only two pairs of circulating water pumps are operating. During this time, the water level in the return trough can be lowered to allow draining of the idle cell basins.

57. Valves. Four motor-operated butterfly valves, two 96-inch diameter and two 84-inch diameter, will be installed in the underground piping to allow rapid changeover from the once-through system to the closed loop system and vice versa. Aside from initial system changeover, these valves will be exercised only for maintenance and emergency reasons. The valves will be inclosed in reinforced concrete pits with manhole access to the ground surface as shown on plate 6. Each pit will be provided with a sump pump for drainage.

58. Water treatment. Tailrace water analyses received for four consecutive seasons were evaluated. Computation of Langelier and Ryznar indices indicates that the tailrace water, which will be used for system makeup, is slightly corrosive. However, there are no known corrosion or biological problems in the existing once-through system. Increased temperatures and cycles of concentration inherent in the new recirculating cooling system will require a water treatment approach consisting of the following:

a. Continuous blowdown system.
b. Chlorination system.
c. Dispersant addition system.
d. pH monitoring system.

59. All water treatment will be accomplished from a water treatment building to be located adjacent to the cooling tower. Construction and service characteristics of the water treatment building will be identical to the chlorination/-chemical feed faiclity at any modern sewage treatment plant. The concrete and steel structure will consist of two separate rooms and an open-sided roofed storage and loading area as shown on plate 7. Vehicle access will be provided for delivery of chemicals. An auxiliary control panel for cooling tower operation will also be inclosed to facilitate operation and maintenace procedures.

60. At tower design conditions, latent heat transfer will result in evaporation of 3,000 gpm of water from the system with a resulting increase in concentration of dissolved and suspended solids. Concentrating to the range of 10 to 15 cycles will cause the water to become slightly scale forming which is desirable. The concentration level will be maintained by continuous blowdown of approximately 300 gpm from the system. The blowdown rate will be automatically controlled based on water conductivity which will be monitored with a meter and recorder. The heater water blowdown will be released through a new 8-inch diameter cast iron pipeline extending from the cooling tower inlet, under the SCL railroad tracks, to the existing ash pond. A nozzle or splash block will be provided at the outlet to dissipate excess energy and provide some cooling and aeration of the flow. Utilizing the ash pond allows ample detention time for residual chlorine concentrations to decay to acceptable levels. Discharge from the ash pond has sometimes exceeded permit limtis for oil and heavy metals; however, these limits are based on effluent concentrations and dilution with cooling tower blowdown may even improve the situation.

61. The chlorination system is used to control any potential biological problems in the condenser and at the cooling tower. One 8,000-lbs/day chlorinator and one 8,000-lbs/day evaporator will provide a dosage of slightly more than 4 mg/l to the 159,000-gpm water flow. The system will be operated only as required, but not more than 2 hours per day. The chlorine will be injected through a diffuser pipe at the cooling water return flume. Chlorine will be received and stored in standardized ton cylinders. Two cylinders at a time will be manifolded to the evaporator, providing a minimum 3-day supply. Residual chlorine will be monitored with a meter, recorder, and high level alarm.

62. A dispersant system is included to provide protection against suspended solids settling out in the recirculating system. It is anticipated that dispersant addition will probably be required only a few months each year. The dispersant will be an anionic acrylic type, such as Nalco 7388. The dispersant

will be injected in the cooling tower cold water discharge to maintain a dosage of 30 to 40 mg/l. This will provide protection for suspended solid levels up to 200 to 400 mg/l. Should increased levels of silt be present in the makeup from the tailrace canal, increased blowdown may be necessary to reduce suspended solids, thereby yielding a reduction in cycles of concentration and resulting in a short-term corrosive environment. Delivery of the dispersant would be in 55-gallon drums with usage of approximately 13 to 18 gallons per day. The dispersant will be injected at the cooling water return flume by positive displacement metering pumps. The pumps will be controlled by the flow rate of cooling tower blowdown to maintain a balanced dosae in the system.

63. The pH monitoring system is recommended as a safety measure to monitor system integrity. It will consist of a meter, recorder, and high and low-level alarms.

64. Three new half-capacity makeup pumps will be located on the existing intake structure for units 3 and 4. The pumps will take a suction from the intake structure downstream from the existing traveling screens. Because of the relatively small 3,300-gpm flow involved in makeup, the traveling screens will not be operated while utilizing close-loop cooling. The makeup pumps will discharge through an automatic valve controlled by level in the cooling tower discharge flume and will then discharge into the 108-inch diameter gravity return line from the cooling tower to the existing pump suction. The makeup pumps will be sized for 2,000 gpm at 60 feet total dynamic head with an expected drop of 5 psi through the level control valve. The pumps will also be used for initial filling of the system. Water loss by draft from the cooling tower should be limited by tower design to 0.008 percent of tower capacity. This quantity of less than 13 gpm does not have any significant affect on water makeup or treatment.

65. Electrical supply and distribution. Electric power for the operation of all cooling system equipment will be obtained from the existing steamplant's 4,160-volt auxiliary buses as shown on plate 10. All 4,160-volt modes will be provided with kWh metering to record power consumption of the cooling system. The three cooling water booster pumps will be served from an extension of the 4,160-volt auxiliary common bus switchgear. The loads at the cooling tower site will be served from a double-ended secondary unit substation receiving 4,160-volt service form auxiliary buses numbered 3 and 4. Small auxiliary electrical loads in the vicinity of the plant such as valve operators, valve vault sump pumps, and makeup water pumps will be served from 480-volt unit substation number C1.

66. Plant 4,160-volt auxiliary switchgear shall be extended by the addition of new circuit breaker units to the present Allis Chalmers lineups. Circuit breaker ratings controls and protective relays shall be designed to be compatible with and similar to existing units. Service at 480-volt for valve operators, sump pumps, and makeup water pumps located near the plant will be obtained from motor control centers of power distribution centers served from 480-volt unit substation number C1. By obtaining service from this substation, these loads will be fed from the same serice as the cooling water booster pumps. Panels, starters, and switches shall be provided as required to serve these loads.

67. A secondary unit substation will be provided in the vicinity of the cooling

tower and adjacent to the chemical feed building. The substation shall consist of the following:

a. Two 4,160-volt to 480/277 volts grounded WYE oil insulated outdoor transformers with self-cooled ratings of 2,000 kVA. Each transfer shall have integral primary disconnect switch interlocked with the secondary main circuit breaker to prevent opnening unless the breaker is tripped.

b. Power air circuit breaker switchgear in outdoor aisleless construction. Circuit breakers shall be electrically operated for control by cooling tower fan control equipment and plant operators.

c. Substation equipment will be configured to serve all cooling loads from either service by closing the substation tie circuit breaker and opening one of the main circuit breakers.

68. Cooling tower lighting and controls and chemical feed building loads will be served from a feeder circuit breaker on the cooling tower unit substation.

69. A concrete encased duct system will be provided between the plant and cooling tower for the routing of 4,160-volt feeders, and control and instrumentation circuits. Manholes shall be provided in which the 4,160-volt feeders are isolated from the control and instrumentation circuits.

70. A grounding electrode system will be established in the area of the new pump station. This will be connected to the plant grounding system and all new pumps and equipment. Another grounding electrode system will be provided at the cooling tower for electrical system and euqipent grounding.

71. Motors for the cooling water booster pumps will be vertical with weather protected NEMA II inclosures and integral heaters. The motor rated voltage will be 4,000 volts, but the motors will be capable of starting the pumps at 85 percent of motor rated voltage. Insulation will be Class B, 80°C rise vacuum pressure impregnated epoxy type. Motors for the cooling tower fans will be totally inclosed fan cooled (TEFC) construction. The motors wil be single speed with a 460-volt rating. The insulation will be Class B. Each fan will be supplied with an integral vibration switch for fan shutdown upon vibration.

72. Controls. The cooling tower fans will be driven by single speed motors. The fans will be automatically controlled to shut down in sequence as the wet bulb temperature drops in order to maintain a minimum 60°F cold water temperature. There will be provisions for peridically rotating duty so that different fans become first out in the system and wear is distributed equally.

73. If a cross-flow cooling tower is selected, the fans should be designated for reverse operation necessitating individual motor starters in addition to the switchgear breakers. This is desirable for removal of ice buildup on the tower inlet louvers by directing the warm air flow out through the louvers melting the ice. If a counter-flow tower is selected, this feature is not necessary as the entire louver area would be naturally flooded by the warm water. Inlet water manifolds on the tower will be furnished by the tower manufacturer. A throttling valve will be provided at each cell to allow balancing of water flow.

74. The cooling water system will have the ability to operate in two modes, a recirculation mode through the cooling tower and a once-through mode as the system is presently operated. The cooling water circulating pumps and cooling water booster pumps will be interlocked to insure matched capacity and head for the mode of operation selected. For the system to operate in the recirculation mode, a permissive for starting the pumps is that the four-motor operated butterfly valves are set in the proper position. The booster pumps and circulation pumps will be interlocked in pairs, No. 1 booster pump to No. 1 circulation pump, etc., to ensure that at all times the capacity through the system is balanced. The pumps should be startd in pairs. However, the new pump pit has enough capacity to allow start of one pump up to 30 seconds before start of the second pump. When once-through operation is selected, the interlock between the two sets of pumps will be broken so that the present cooling water circulating pumps can run alone. However, the cooling water booster pumps will be locked out. As before, proper positioning of the four motor-operated valves will be a permissive for operation of the circulation pumps when in the once-through mode. Since the motor-operated valve will require approximately 30 seconds to change position, appropriate time delays will be built into the interlock system to allow switchover from one mode to the other, while units 3 and 4 are on line. The cooling water booster pump pit is adequately sized to absorb short upsets in the water flow.

75. One makeup pump will operate continuously with a second pump starting automatically as capacity is required. This will allow the pumps to operate closer to design rating during low load periods with reduced tower evaporation rates.

VIEWS OF THE OWNER

76. There have been several meetings held and letters exchanged between the South Carolina Public Service Authority and the Corps during the development of the cooling water facilities at Jefferies Steam Plant. As indicated by the material contained in exhibit F, the Authority is in agreement with the recommended solution in this design memorandum. It is recognized that this recommended plan will necessitate a revision to the existing contract between the Public Service Authority and the Government. These revisions will be developed and submitted at a later date.

ESTIMATED COSTS

77. Cost estimate. The total estimated cost to the Federal Government of the cooling water facilities is $14,250,000. This is the total initial construction estimate of all facilities as outlied on the drawings presented in this design memorandum. No real estate costs are involved because construction will be entirely on the property owned by the South Carolina Public Service Authority. Fifteen percent has been added to the contract cost for contingencies and 14.5 percent for Government costs (8.5 percent for engineerig and design and 6.0 percent for supervision and administration). A detailed cost estimate by item is shown in Table 12. Table 11 is a summary by cost account numbers.

78. Comparison with latest approved estimate. The latest approved estimat , PB-3, dated October 1979, shows a total amount of $5,550,000. The current estimate of $12,500,000 for the construction of a cooling tower and appurtenances

reflects the latest unit price costs and quantities based on feature design memorandum studies. The current PB-3 estimate is based on the construction of a spray pond located on the opposite side of the tailrace canal than the Jefferies Steam Plant. Studies presented in this design memorandum indicate that this is not a workable solution.

TABLE 11

COOPER RIVER REDIVERSION PROJECT
COOLING WATER FACILITIES

Summary Project Cost Estimate
(April 1980 Price Levels)

Cost Account Number	Item or Feature	Current Cost Estimate
07	Powerplant	$12,500,000
30	Engineering and Design (8.5%)	1,000,000
31	Supervision and Administration (6.0%)	750,000
	TOTAL COST	$14,250,000

TABLE 12

COOPER RIVER REDIVERSION PROJECT
COOLING WATER FACILITIES

Detailed Cost Estimate
(April 1980 Price Levels)

Cost Account	Feature	Unit	Quantity	Unit Price	Total Cost
07	Powerplant				
	Site Preparation	LS	Job		65,500
	Unclassified Excavation	CY	53,400	2.50	133,500
	Select Backfill	CY	5,000	11.25	56,300
	Dewatering	LS	Job		45,900
	Shoring	LS	Job		165,200
	Reinforced Concrete				
	Slab-on-Grade	CY	1,833	160.00	293,300
	Walls	CY	733	275.00	201,600
	Elevated Slab	CY	173	325.00	56,200
	Piles (18" Drilled Piers)	LF	17,720	16.25	288,000
	Piles (12 HP 53)	LF	17,470	19.00	332,000
	Tower with PVC Fill	LS	Job		5,200,000
	Chemical Feed Bldg including equipment	LS	Job		169,000
	Booster Pumps and Motors	Ea	3	154,600	463,800
	108-inch Pipe	LF	3,675	625.00	2,296,900
	8-inch blowdown Pipe	LF	660	55.00	36,300
	96-inch Butterfly Valves	Ea	2	76,200	152,400
	84-inch Butterfly Valves	Ea	2	66,700	133,400
	Miscellaneous Valves	LS	Job		68,300
	60-inch Overflow Pipe	LF	50	100.00	5,000
	Inlet Screen	Ea	1	18,000	18,000
	Misc Metals	Ton	3	2,000	6,000
	Electrical	LS	Job		725,000
	Account 07 Subtotal				$10,911,600
	Contingencies, 15%				1,588,400
	Account 07 Total				$12,500,000
30	Engineering and Design, 8.5%				1,000,000
31	Supervision & Administration, 6.0%				750,000
	TOTAL COST				$14,250,000

PLAN IMPLEMENTATION

79. In order to obtain the most optimum design and construction durations, it will be necessary to develop, advertise and award five separate contracts to

implement the proposed scheme. Three of these will be supply contracts, one will be supply and install, and the fifth will be a general construction contract. This approach is necessary because of the long lead time required for procurement of some of the components of the proposed cooling water scheme. In addition, the configuration of the cooling tower has to be known before the plans and specifications for the general construction contract can be finalized. A bar chart depicting this plan of action is shown in exhibit G.

RECOMMENDATION

80. It is recommended that the mechanical draft cooling tower scheme as described in this design memorandum be approved as a basis for continued detailed planning and preparation of plans and specifications for the procurement of the cooling tower, 53,000 gpm pumps and motors, 84-inch and 96-inch valves, the large diameter pipe and, finally, the preparation of plans and specifications for the general construction contract.

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

EXHIBIT A

EVALUATION BY WES OF
ADDITIONAL FLOW RELEASES FROM PINOPOLIS

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION
CORPS OF ENGINEERS
P O BOX 631
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESHE

23 May 1980

SUBJECT: Determination of Shoaling Due to Minimum Cooling Water Releases, Pinopolis Power House, Santee-Cooper Rediversion Project

District Engineer
U. S. Army Engineer District, Savannah
ATTN: SASEN-H
P. O. Box 889
Savannah, GA 31402

1. The Hydraulics Laboratory study team has completed the effort to develop guidance on shoaling to assist your office in the determination of the most effective method to meet cooling water requirements for power production at plants located below the Pinopolis Power House on the Cooper River. Results of that effort are summarized in Inclosure 1.

2. If you have any questions, please contact Mr. Richard A. Sager, FTS 542-3398.

FOR THE COMMANDER AND DIRECTOR:

1 Incl
as

H. B. Simmons

H. B. SIMMONS
Engineer
Chief, Hydraulics Laboratory

SHOALING ANALYSIS FOR COOPER RIVER
TO DETERMINE RATES OF SHOALING FOR COOLING WATER RELEASES
FROM PINOPOLIS POWER HOUSE FOR SANTEE-COOPER REDIVERSION PROJECT

Introduction

1. The Savannah District (SAS) was tasked with the responsibility of determining the most effective method to meet cooling water requirements for power production at plants located below the Pinopolis Power House on the Cooper River. They determined that the weekly average releases to satisfy these requirements could be as much as 5232 cfs, as compared to the 3000-cfs average weekly discharge requirement for Pinopolis releases under the rediversion plan. As a part of the study, the impact of the cooling water releases on shoaling volumes was required to define additional costs that would be incurred to remove the shoal material.

2. In order to define dredging requirements, SAS asked the Waterways Experiment Station (WES) to provide guidance on the following questions:

a. What is the annual shoaling in Charleston Harbor with a constant weekly average release from Pinopolis between 5200 and 5300 cfs, assuming stratification has occurred?

b. It may be possible to estimate annual shoaling for cooling release operations 10, 20, 30, 50, and 100 percent of the time by assuming it to be these percentages of annual shoaling due to constant weekly releases between 5200 and 5300 cfs. Do you feel time required for stratification to occur after weekly releases is increased and time required for mixing to reoccur after release is decreased to 3000 cfs should be taken into account?

c. If so, what is the time required for Charleston Harbor to stratify following an increase in weekly average release from 3000 to 5300 cfs? How long before mixing again occurs after weekly releases are reduced to 3000 cfs?

Approach

3. In the limited time available to provide guidance to the questions, response was based only on data already available or that which could be developed in a short period of time. In particular, one of the major limitations in the analysis is an understanding of the actual shoaling that has occurred annually since the mid-1960's. Contact with the Charleston District (SAC) confirmed that information is available to develop these data; however, time constraints prohibited the development of such data. The information that was used to provide guidance to the question was based on:

a. Results of model studies conducted at WES.

b. Shoaling analysis of the Cooper River completed by SAC in the mid-1960's.

c. Analysis of flow predominance versus shoaling for Charleston Harbor completed by WES personnel in the late 1960's.

4. Prototype data are available for two general flow conditions, i.e., around 15,600 cfs and 72 cfs. Since the area of interest is shoaling for flows of 5200 to 5300 cfs, interpolation between these sets of data is required.

5. The model data provide the major basis to define the expected shoaling relationships for the range of flows between 72 and 15,600 cfs.

Shoaling at 15,600-cfs freshwater inflow

6. Since data for current conditions could require a considerable time to develop, the data for the analysis conducted by SAC in 1966 were used with one modification. In the entrance area, shoaling was assumed to occur from two basic processes--littoral transport into the channel through the low weir in each jetty and around the outer ends of the jetties and transport into the entrance area due to density currents. Data available from the pre-Santee-Cooper rediversion project indicated that, for the period 1930 to 1940, an average entrance channel shoaling rate of 250,000 cubic yards per year was incurred; however, this was with a 30-foot navigation channel. Since the channel is presently maintained at a 35-foot depth, experience at other entrances indicates that an increased shoaling rate would be incurred for the deepened channel at a weekly average discharge of 72 cfs. A technical basis is not readily available to predict the magnitude of the increase; however, an increase of 100,000 cubic yards per year was assumed for a total of 350,000 cubic yards per year.

7. The shoaling rates for the remaining portions of the Cooper River are taken directly from the SAC report and are shown in Table 1.

Shoaling at 72-cfs freshwater inflow

8. Various reports address the shoaling rate that occurred in Charleston Harbor prior to 1942. In general, the reported amounts range from 80,000 to 180,000 cubic yards. In view of the variation, a shoaling rate of 120,000 cubic yards appears to be reasonable. Since this estimate was based on data for a 30-foot navigation channel, and presently a 35-foot channel exists, the results of the model study which show an increase of 10 percent in shoaling for a 5-foot channel depth increase were applied. The resulting shoaling for 72 cfs and a 35-foot navigation channel is 132,000 cubic yards.

9. Predictions for potential shoaling areas added to the Cooper River system since 1942 were based primarily on the distribution of shoaling existing in Charleston Harbor prior to 1942 as shown in Figure 1.

10. Inspection of Figure 1 shows that little if any shoaling occurred in the upper end of the Charleston Harbor prior to 1940; therefore, the assumption was made that no shoaling would have occurred for such conditions in the Noise Measurement Facility, Naval Ammunition Depot, and Goose Creek channels.

11. Although the geometry and alignment of slips and docks encourage shoaling, the Navy facilities are generally located in a portion of the navigation channel that experienced limited or no shoaling. Since no firm basis existed to indicate shoaling, no shoaling is assumed for the Navy or other slips and docks.

12. The channel shoaling that existed at the entrance to Shipyard River was close to the upper end of the shoaling experienced upstream from the mouth of the Wando River. Since the entrance was at the upstream end of the shoal, some shoaling could occur; however, a limited amount of material would move into the area. In view of the expected limited shoaling, no material was assumed for Shipyard River.

13. Shem Creek is fairly well removed from the areas of shoaling indicated for a flow of 72 cfs; therefore, no basis exists for a shoaling prediction for this area.

14. The Anchorage Basin is near an indicated area of shoaling in the main navigation channel and is the most probable of the additions since 1942 to incur shoaling. Recognizing this probability, but lacking a basis for a reasonable prediction, no shoaling is also assumed for this area.

15. In summary, for the pre-Santee-Cooper inflow of 72 cfs and a 35-foot channel, the shoaling for the navigation channel is assumed as 482,000 cubic yards per year (132,000 in the Charleston Harbor channel and 350,000 in the entrance channel), and the remaining areas are assumed to incur no shoaling. Both of the assumptions should tend to be low.

Transition conditions between 72 and 15,600 cfs

16. Information immediately available to estimate shoaling rates for flows between 72 and 15,600 cfs consists primarily of model test results. Shoaling tests were conducted for Pinopolis discharges of 3000 cfs and 15,600 cfs. Flow predominance data are available for flows from 2500 to 15,600 cfs.

17. The results of the model shoaling tests indicated a 92 percent reduction would occur when the Pinopolis discharge is reduced from 15,600 cfs to 3000 cfs. Although the model tests did not include all features

presently in existence, inspection of flow predominance data for the area of each feature indicates that applying the 92 percent reduction appears reasonable.

18. The locations of flow predominance (velocity) stations are shown in Figure 2. Flow predominance data for these areas indicate that for flows up to about 3500 cfs some shoaling increase will occur. Data (Figures 3 through 15) for the 5000-cfs discharge indicate that significant changes in flow predominance have occurred in portions of the navigation channel, indicating an increased potential for shoaling. In addition, a significant change in stratification has occurred. Further inspection of the flow predominance data indicates that, with increased flow above 5000 cfs, the potential for increased shoaling continues to exist. The change indicated is that the locations of the shoaling will change within the channel, up to the 15,600-cfs discharge. The limited data do indicate that a major change in shoaling potential exists for all flows in excess of 5000 cfs. Increases in shoaling above 5000 cfs were assumed to increase at the same rate that occurred from 0 to 3500 cfs and are considered to be preimarily attributable to sediment supply.

19. The data do indicate that the start of the major increase in shoaling will occur above 3500 cfs and below 5000 cfs. No basis exists to establish this exact discharge. The development of the discharge-shoaling relationship was based on the assumption that the drastic change in shoaling rate starts at a 4000-cfs Pinopolis release and is completed by the time a 5000-cfs discharge is achieved.

20. Two procedures were used in the development of the discharge-shoaling relationship. Procedure 1 is a simplified analysis based on a straight-lined interpolation of all shoaling outside the navigation channel for flows between 0 and 15,600 cfs. Also shoaling reaches (Figure 16) identified to be grouped with the Charleston Harbor navigation channel results are: Noise Measurements Facility, Naval Ammunition Depot (NAD) channel, Goose Creek, other slips and docks, and Shem Creek. Procedure 2 is a less simplified analysis based on interpretation of model flow predominance to determine shoaling rates outside the channel for intermediate discharges. In Procedure 2 shoaling reaches identified to be grouped with the Charleston Harbor navigation channel results are: Noise Measurement Facility, Naval Ammunition Depot (NAD) channel, and Entrance Channel (350,000 cubic yards considered as littoral drift).

21. Procedure 1. The resulting discharge shoaling relationship using Procedure 1 is shown in Figure 17. For the curve marked 1, the shoaling (4,388,000 cubic yards) for a discharge of 15,600 cfs is the sum of the volumes in Table 1 for the six areas listed in paragraph 20. The shoaling (351,000 cubic yards) for 3000 cfs was taken as a 92 percent reduction from the 15,600-cfs rate as determined from the model. The rate (132,000 cubic yards) of 72 cfs was taken from Table 1. A straight line was drawn

through the 72- and 3000-cfs points and extended to 4000 cfs. The slope of this line was also used to define the line from 15,600 cfs down to 5000 cfs. Finally, the 4000- and 5000-cfs points were connected by a straight line.

22. A similar procedure was used to develop relationships for the four remaining shoaling areas. Flow predominance relationships are shown in Figures 3 through 15. Data from Velocity Station 103 (Figure 12) in the navigation channel along the Naval slips and docks indicate a balanced flow predominance at approximately 3000-cfs Pinopolis discharge. Inspection of data for other nearby stations (60, 117-R, 62) indicates that the maximum flood predominance occurs at approximately 5000 cfs. These two flows were selected as the extremes of the zone of major change in shoaling for the Naval slips and docks, thus defining the transition zone for curve 2 in Figure 17.

23. Data available at Stations 55-L and 56 (Figures 9 and 10) in the area of Shipyard River indicate that balanced flow predominance occurs at approximately 3000 cfs with a maximum flood predominance at 10,000 cfs. These two points were selected as the zone of major change in shoaling for Shipyard River (curve 3 in Figure 17).

24. Analysis of the data in the area of the Anchorage Basin included recognization of the major changes that have occurred in the area since the flow predominance data were determined from the model data. These major changes include the location of the navigation channel and construction of the Anchorage Basin. The two velocity stations that were used to develop the zone of major change were 104 and 31 (Figure 3). The data from Station 104 indicate that balanced predominance occurs at 2500 cfs with a slight ebb predominance at 5000 cfs. Data for Station 31 indicate flood predominance at all discharges of interest. Since data from Station 104 indicate a balanced flow below 5000 cfs, 4000 cfs was selected to the lower limit of the transition zone. The maximum flood predominance at Station 104 was at a discharge of 10,000 cfs. This was selected for the upper end of the transition zone, as shown by curve 4 in Figure 17.

25. Since the entrance area was the only area directly influenced by the littoral transport, a somewhat different analysis procedure was applied. The data available for a discharge of 72 cfs adjusted for the increase in channel depth indicated a shoaling rate of 350,000 cubic yards, and it is assumed that that was entirely from littoral transport into the area. Inspection of the flow predominance data between the jetties (Station 119, Figure 15) indicates no change in flow predominance for a 0- and 2500- cfs discharge. Since the ebb flow predominance is reduced for a 5000-cfs discharge, the potential for deposition is increased. At the 7500-cfs discharge, an essentially balanced flow predominance exists. These two flows, 2500 cfs and 7500 cfs, were selected as the ends of the major transition zone. In this case, the slope of the line

between 72 and 2500 cfs was flat; thus, the slope from 7500 to 15,600 cfs also was assumed to be flat.

26. Procedure 2. The resulting discharge shoaling relationship using Procedure 2 is shown in Figure 18. For the navigation channel curve the shoaling (5,120,000 cubic yards) for a discharge of 15,600 cfs is the sum of the volumes in Table 1 for the four areas listed in paragraph 20. The shoaling (409,600 cubic yards) for 3000 cfs was taken as a 92 percent reduction from the 15,600-cfs rate as determined from the model. The rate (132,000 cubic yards) of 72 cfs was taken from Table 1. A straight line was drawn through the 72- and 3000-cfs points and extended to 4000 cfs. The slope of this line was also used to define the line from 15,600 cfs down to 5000 cfs. Finally, the 4000- and 5000-cfs points were connected by a straight line.

27. For the curve marked all others, the shoaling (4,678,000 cubic yards) for a discharge of 15,600 cfs is the sum of the volumes in Table 1 for the remaining six areas. A straight line was drawn from the 15,600-cfs point down to 0 cfs.

28. With the development of discharge-shoaling relationships for both Procedures 1 and 2 for all significant portions of the Cooper River, a combined projection (Figure 19) was completed. Based on these projections, estimated shoaling for the 5200- to 5300-cfs range is 7,400,000 cubic yards per year for Procedure 1 and 5,900,000 cubic yards for Procedure 2. The projections estimated shoaling for 3000 cfs to be 1,100,000 cubic yards for Procedure 1 and 1,600,000 cubic yards for Procedure 2. These projections are based on an analysis that could be reasonably accomplished in a short period of time. If results of economic studies based on data presented in this report are marginal, it is recommended that a more thorough analysis be conducted to develop a more accurate prediction of shoaling. This analysis did not include any consideration of data that exist since the mid-1960's nor detailed consideration of data that were used for this analysis. Information exists to allow more refined predictions to be developed.

29. The analysis of the shoaling was focused on the best possible projection of shoaling in the 5200- to 5300-cfs range. During the course of the development of these projections, there was some evidence that, for certain areas of the Cooper River, shoaling predictions may be low in the 3000- to 4000-cfs range and in the 7500- to 10,000-cfs range. Refinements to these areas of the projections were not explored further since they were not estimated to have an impact on the 5200- to 5300-cfs range of the predictions. A more detailed analysis of the available data and development of shoaling data from existing information would allow these assumptions to be investigated in more detail.

30. Investigation of available data does not provide a basis to define the response time for flow changes. Lacking any basis to predict the influence of flow changes, it was assumed that the shoaling rate increase resulting from periodic or continuous weekly average discharges greater than 3000 cfs would be directly proportional to the percentage of time that the higher discharge is released from Pinopolis. Estimates of annual shoaling for various percents of time of 5200-cfs releases from Pinopolis are:

Percent of Time Weekly Discharge is 5200 cfs	Annual Shoaling (Cu Yd)	
	Procedure 1	Procedure 2
0	1,100,000	1,600,000
10	1,730,000	2,030,000
20	2,360,000	2,460,000
30	2,990,000	2,890,000
50	4,250,000	3,750,000
100	7,400,000	5,900,000

Table 1

Cooper River
Shoaling Analysis for Various Cooper River Flows

Shoaling Reach	Shoaling in Thousands of Cubic Yards 72 cfs	15,600 cfs
Noise Measurement Facility	0	120
Naval Ammunition Depot Channel	0	840
Goose Creek	0	36
Charleston Harbor	132	3260
Navy Slips and Docks	0	3000
Shipyard River	0	790
Other Slips and Docks	0	130
Shem Creek	0	2
Anchorage Basin	0	720
Entrance Channel	350	1250*
TOTALS	482	10148

*350 cubic yards from littoral currents; 900 cubic yards from F.W. flow

NOTE: All shoaling volumes are for conditions of a 35-foot-deep navigation channel.

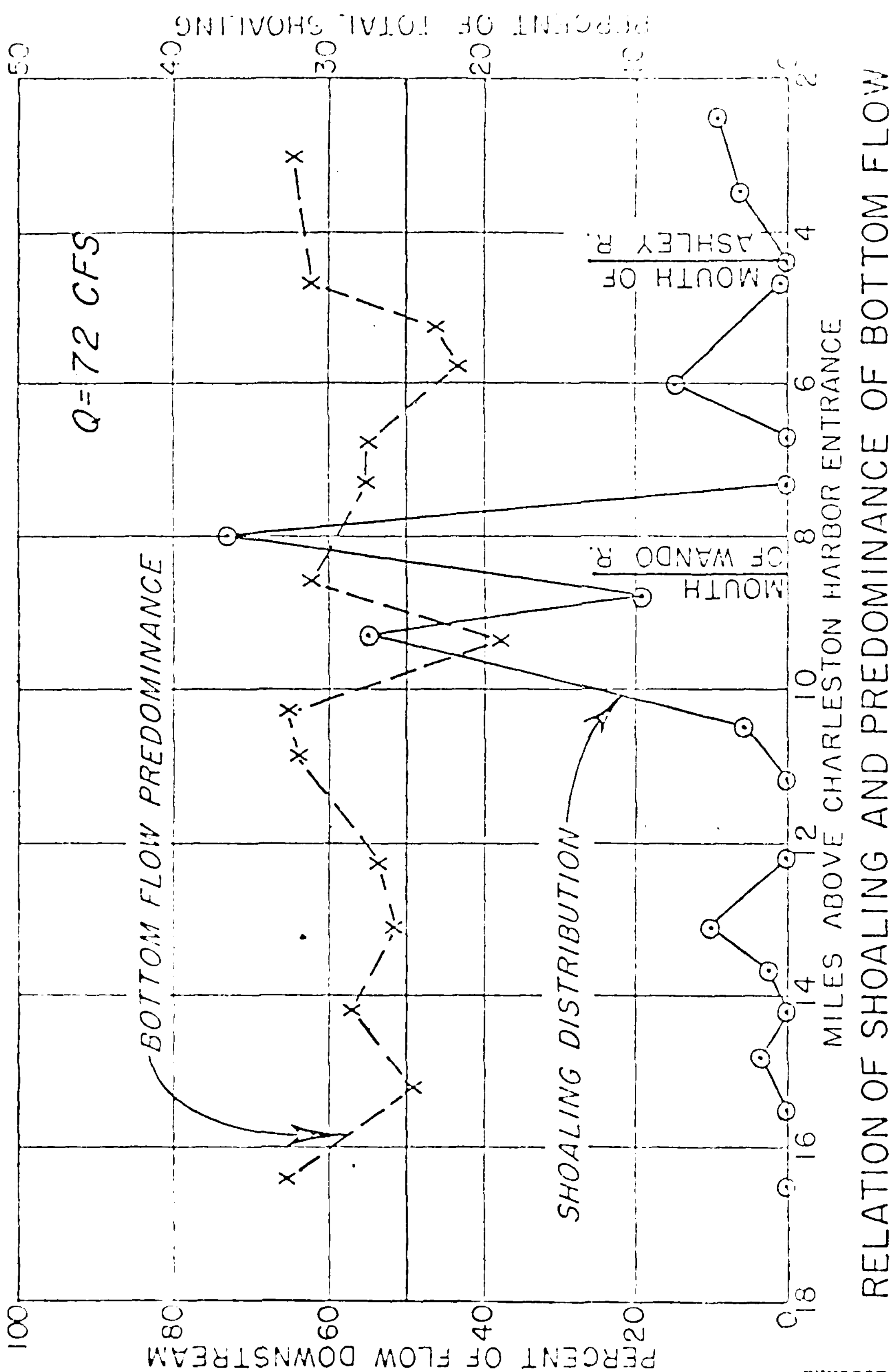


EXHIBIT A
Page 10 of 28

FIGURE 1

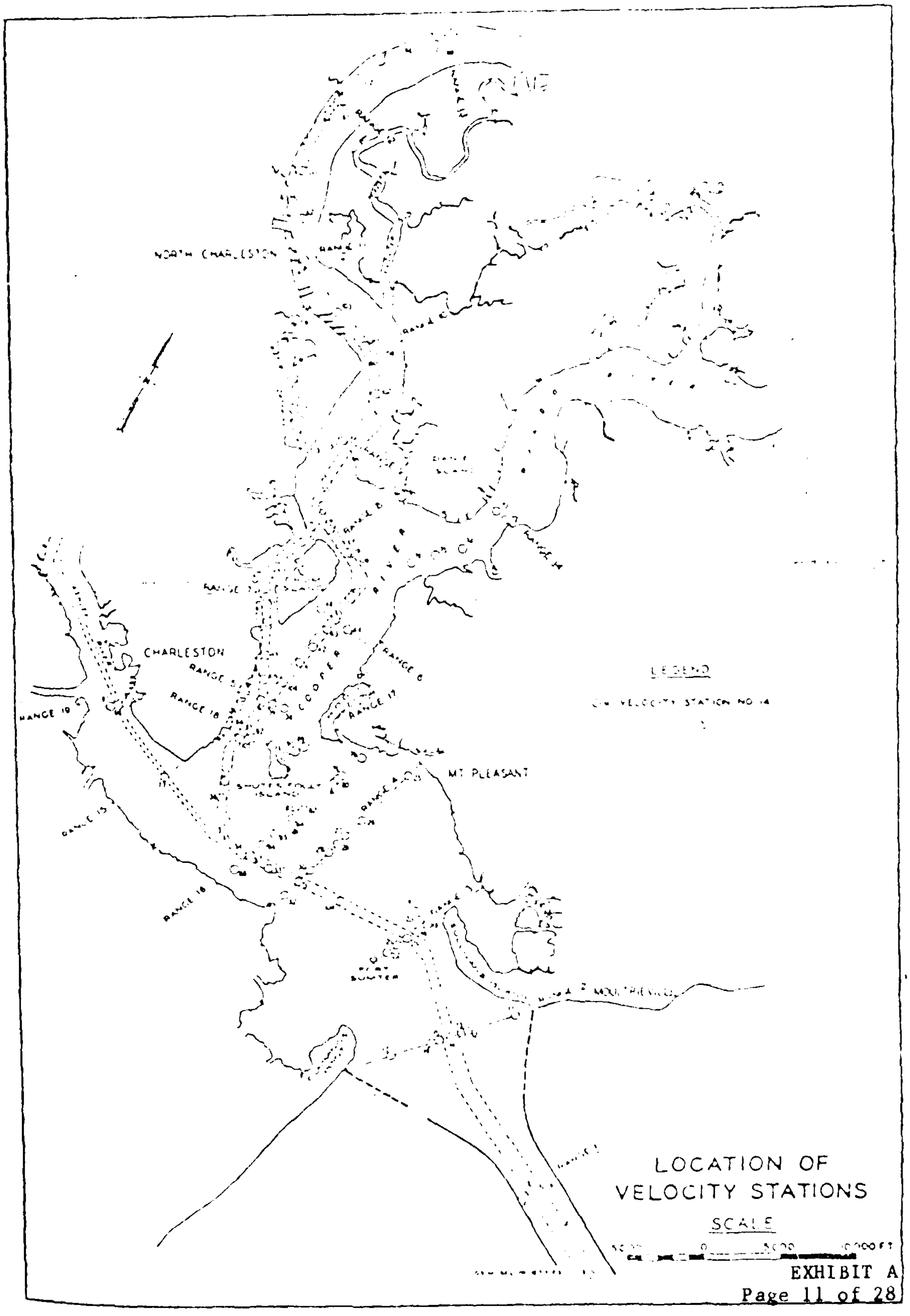


EXHIBIT A
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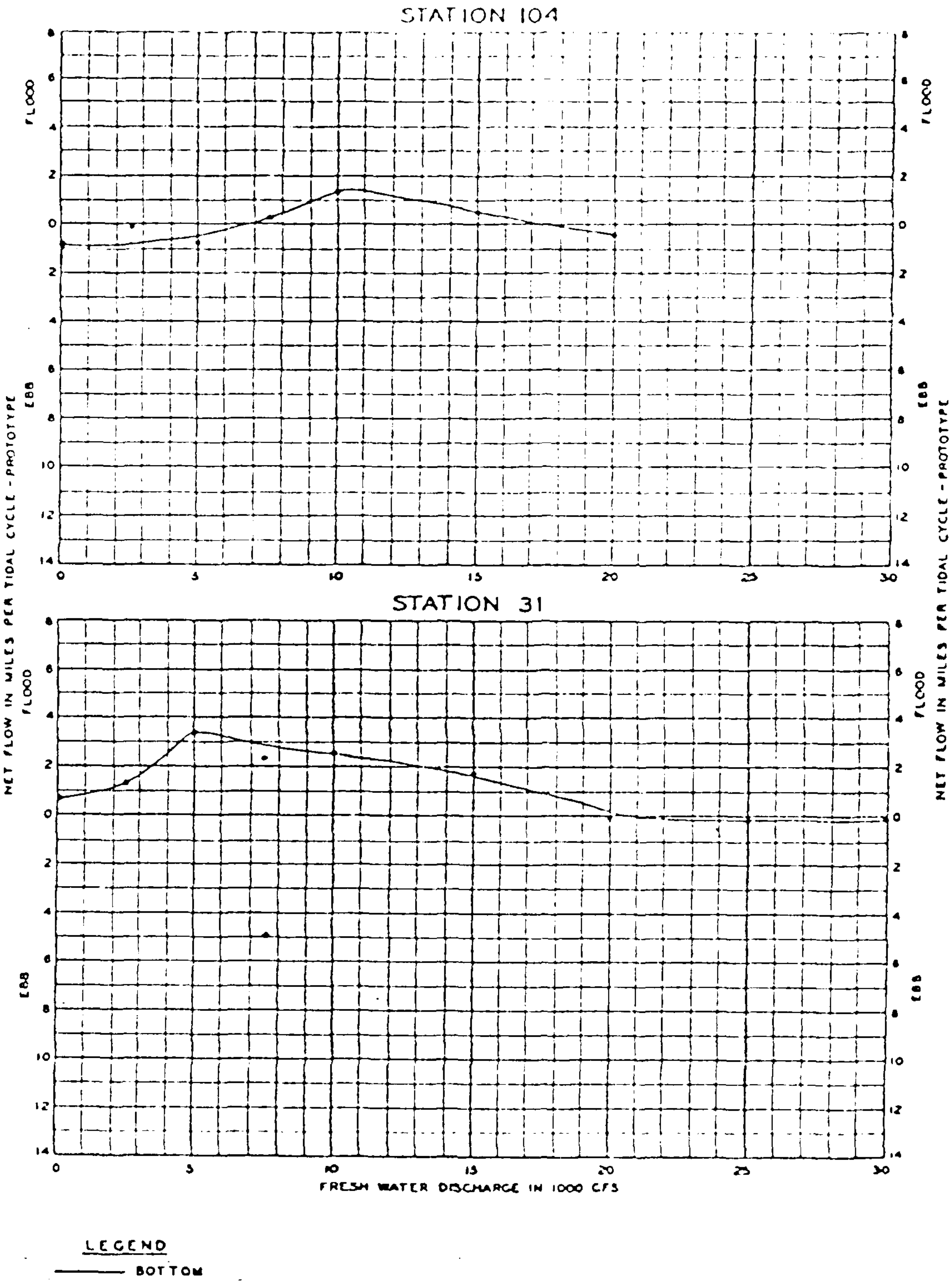
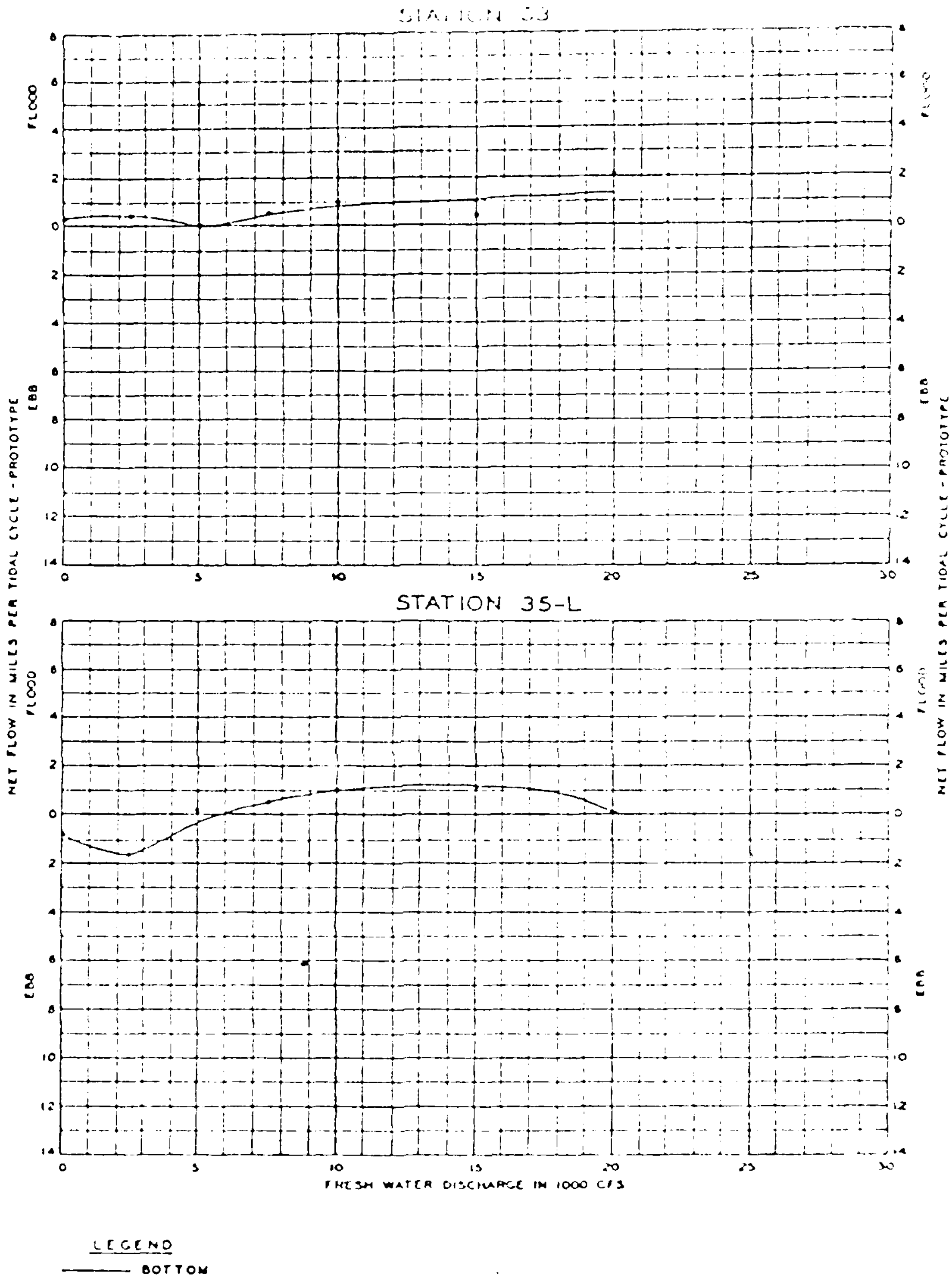
FIGURE 2



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A

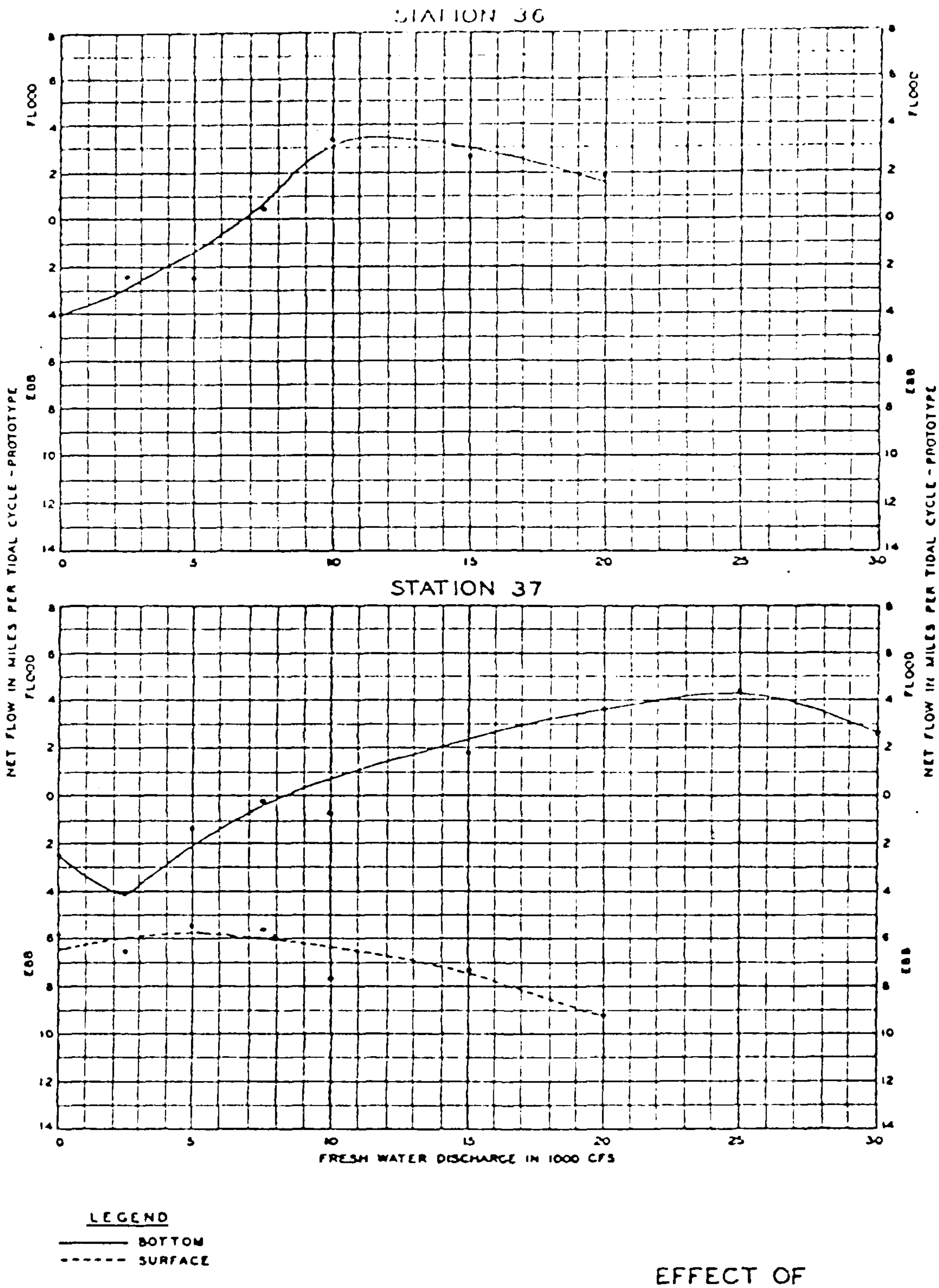
FIGURE 3



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A

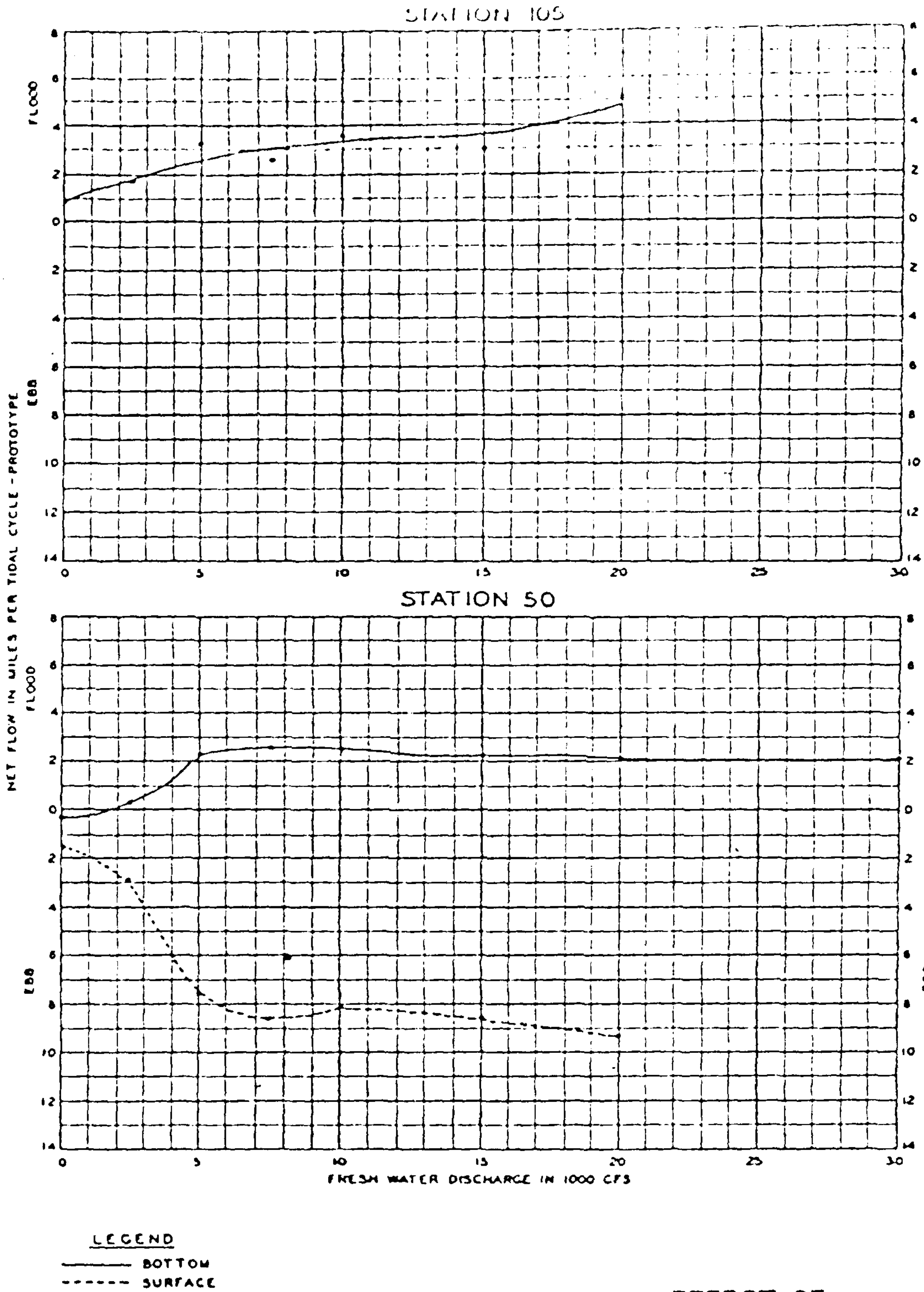
FIGURE 4



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A

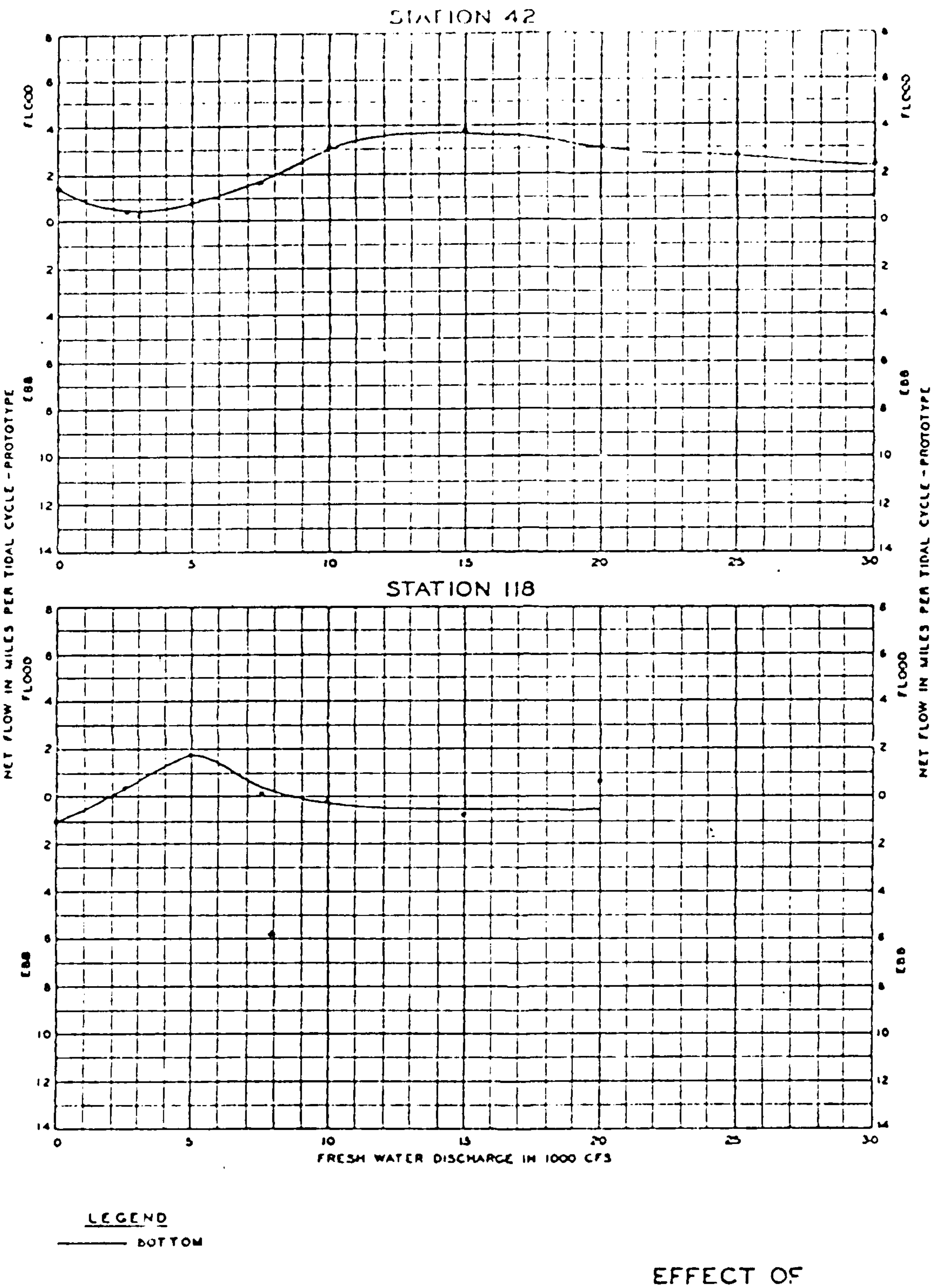
FIGURE 5



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A

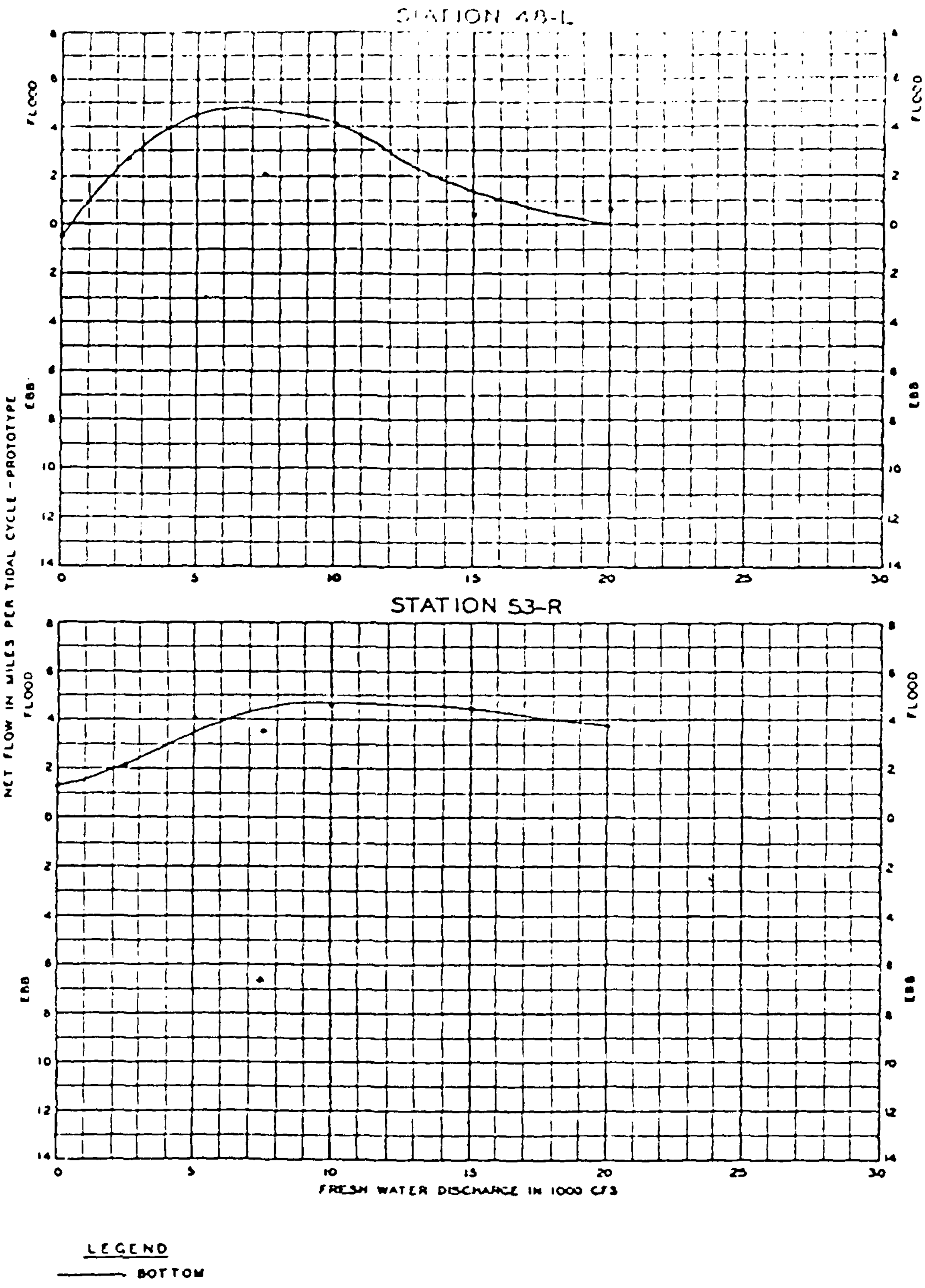
FIGURE 6



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A
Page 16 of 28

FIGURE 7

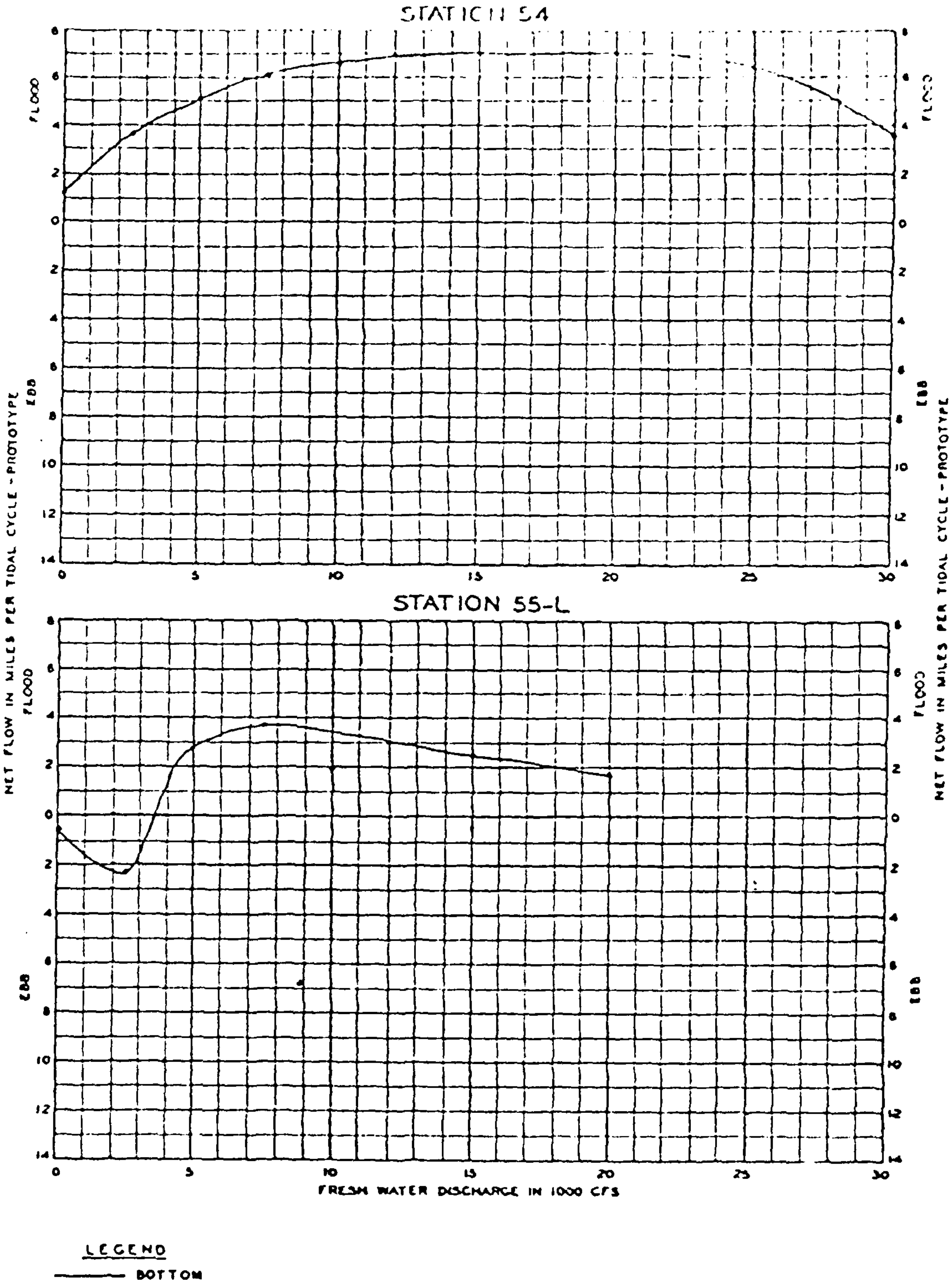


EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A

~~Page 17 of 28~~

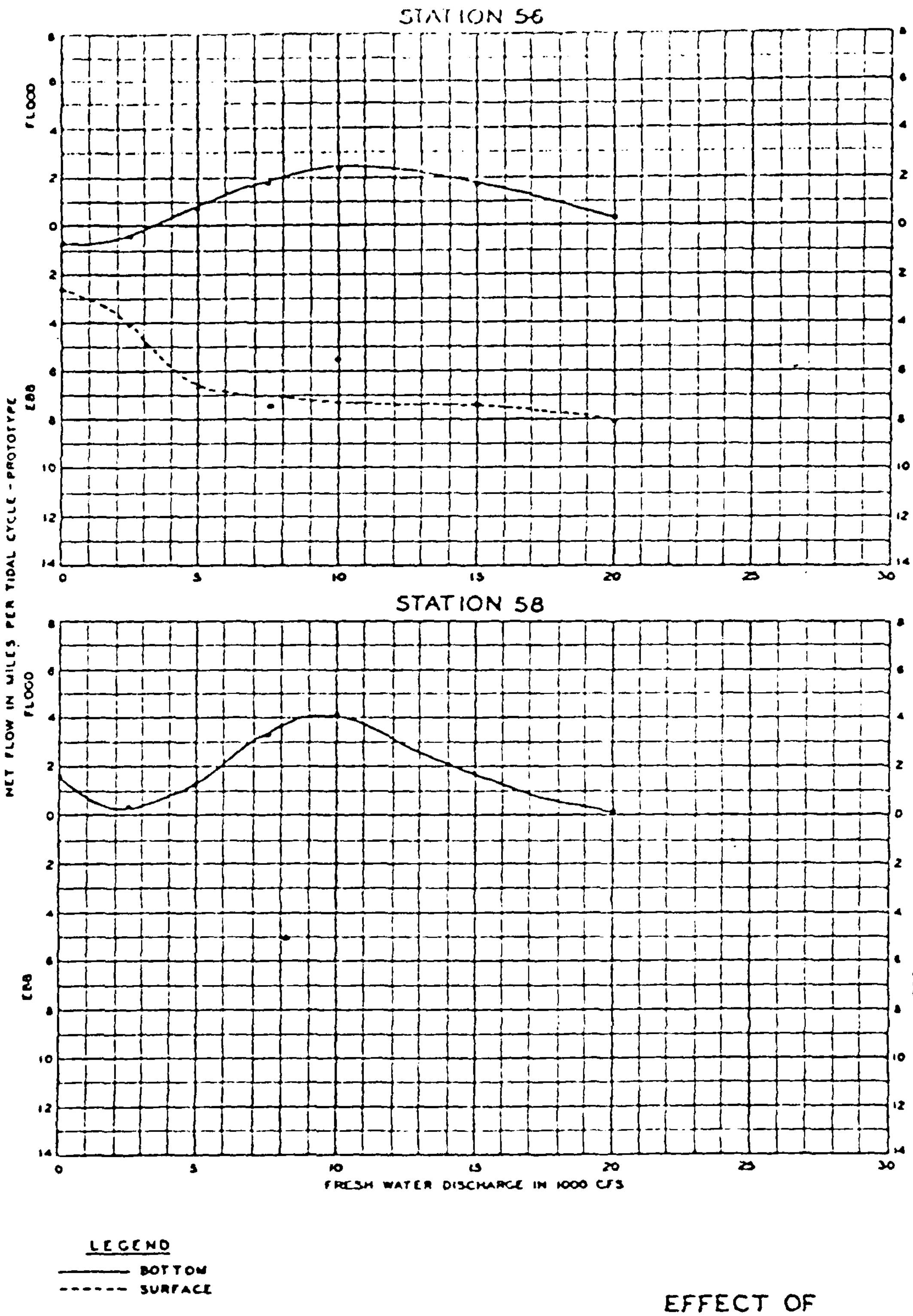
FIGURE 8



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A
Page 18 of 28

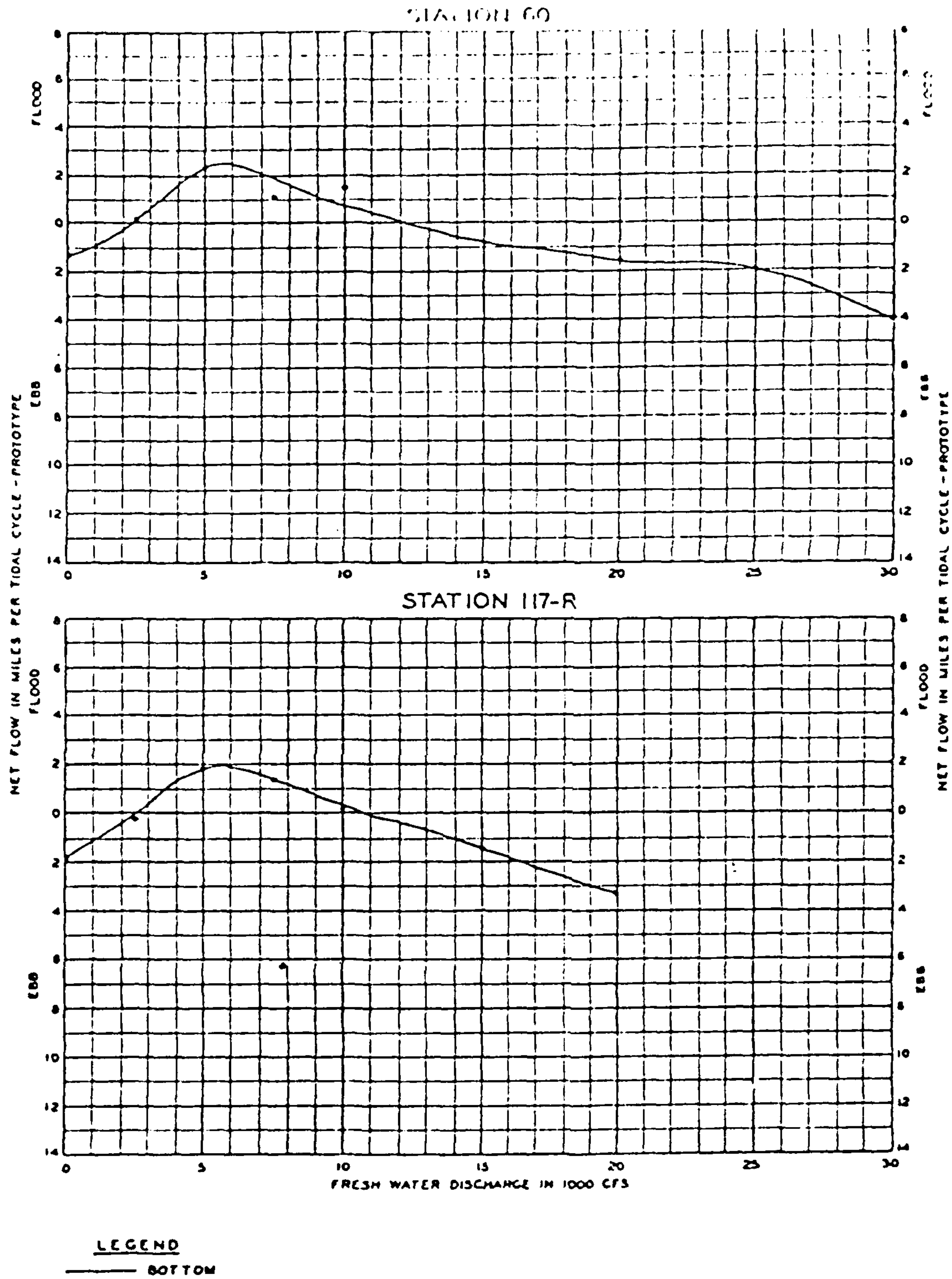
FIGURE 9



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A

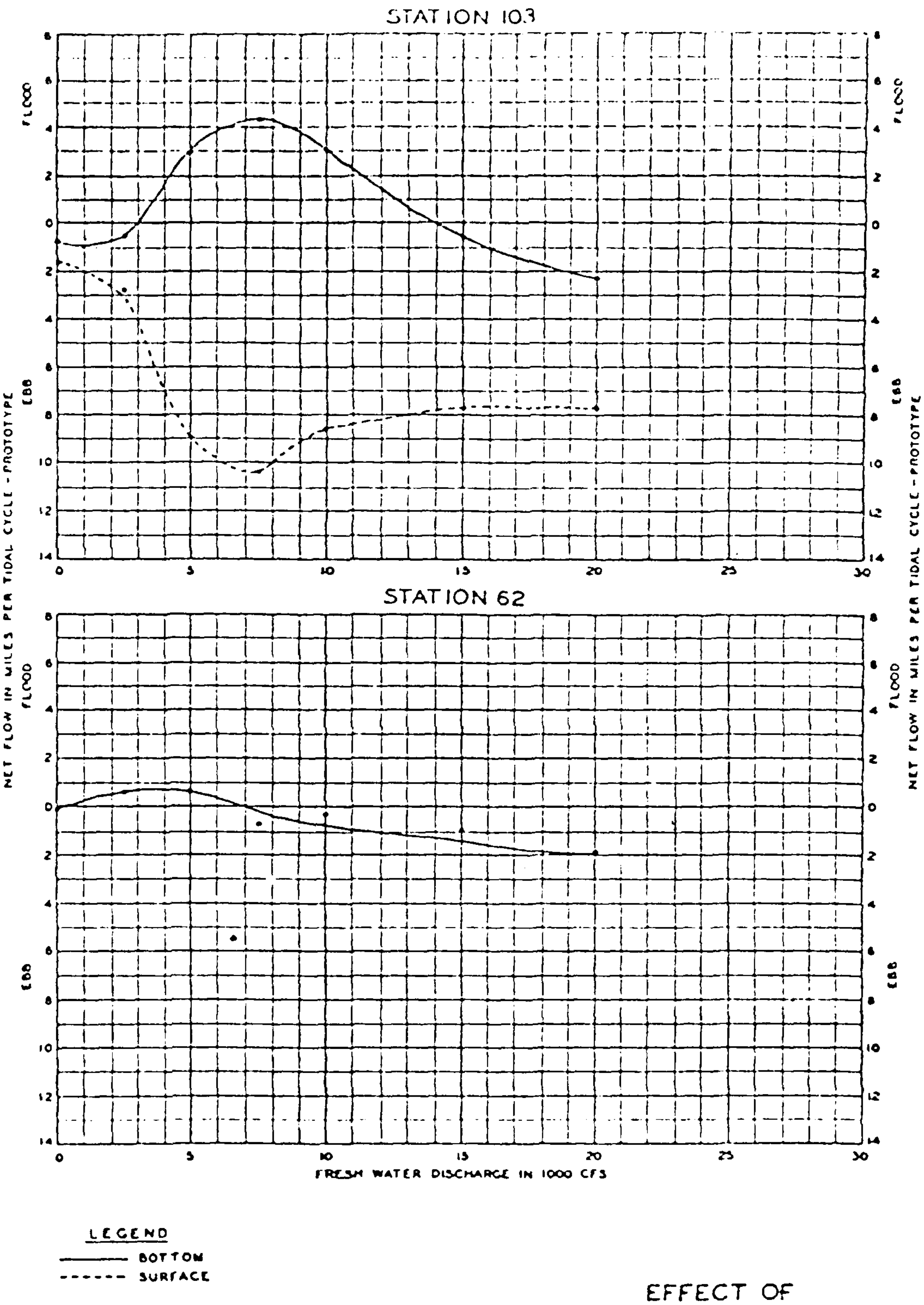
FIGURE 10



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

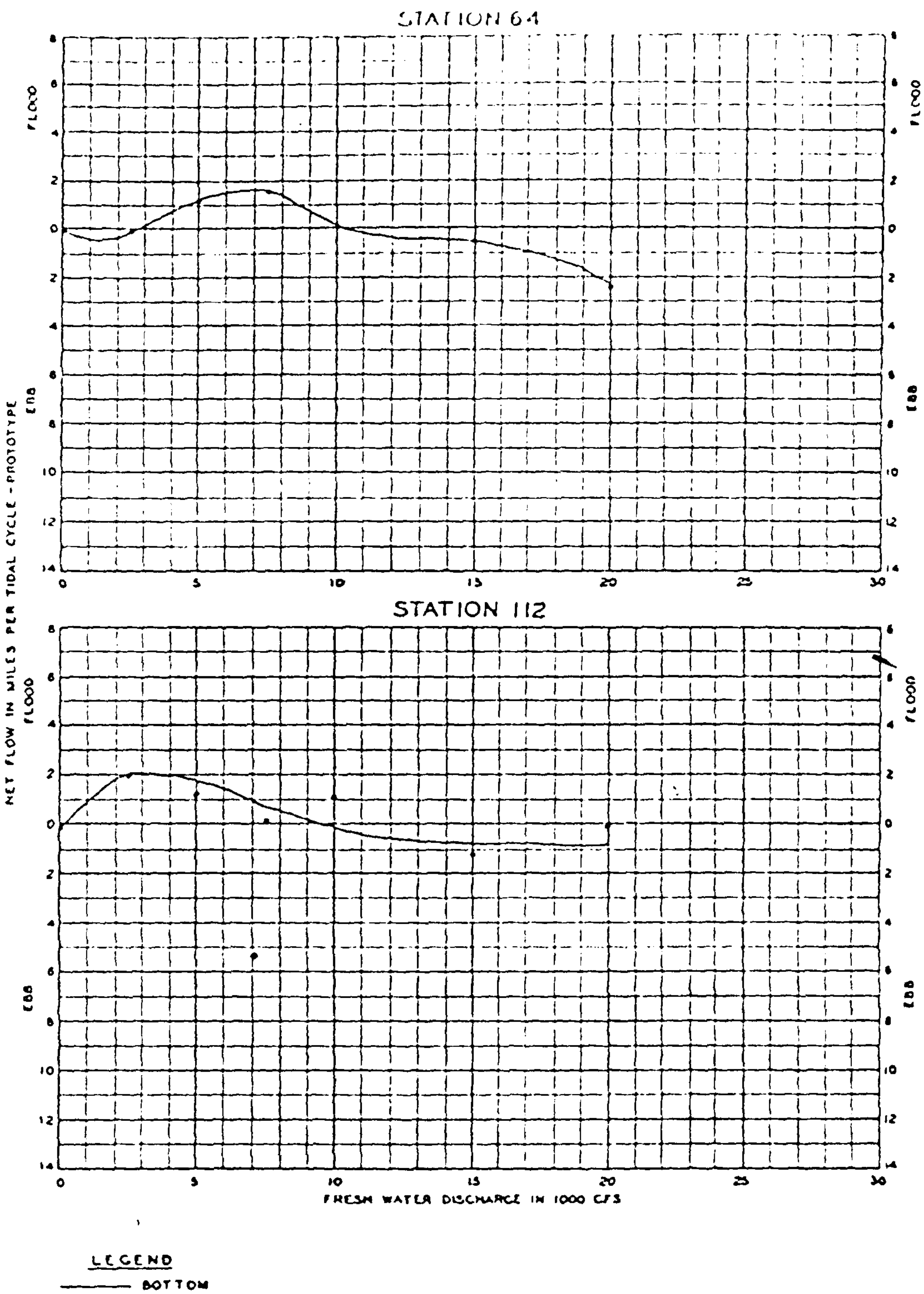
EXHIBIT A

FIGURE 11



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

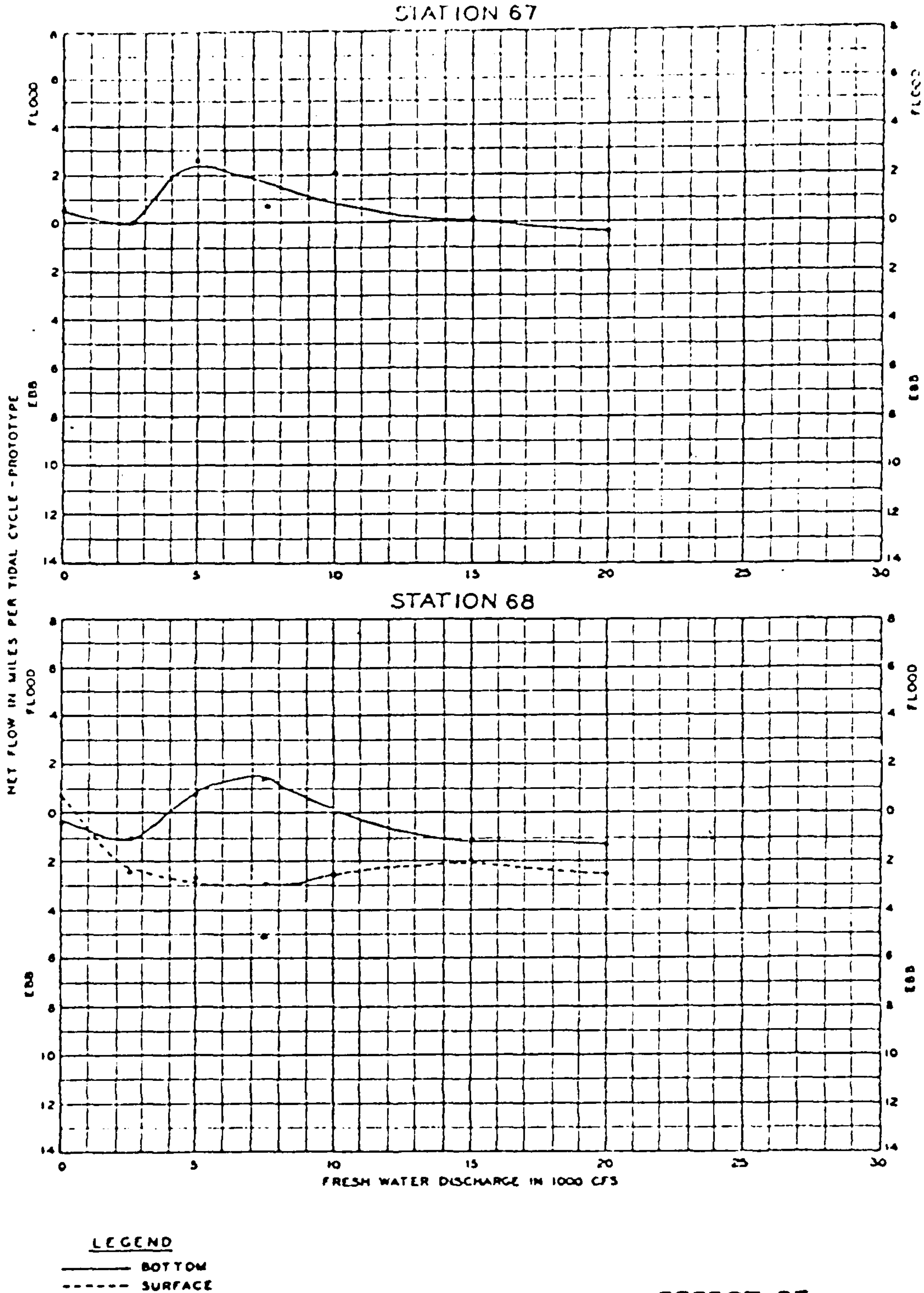
FIGURE 12



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A
Page 22 of 28

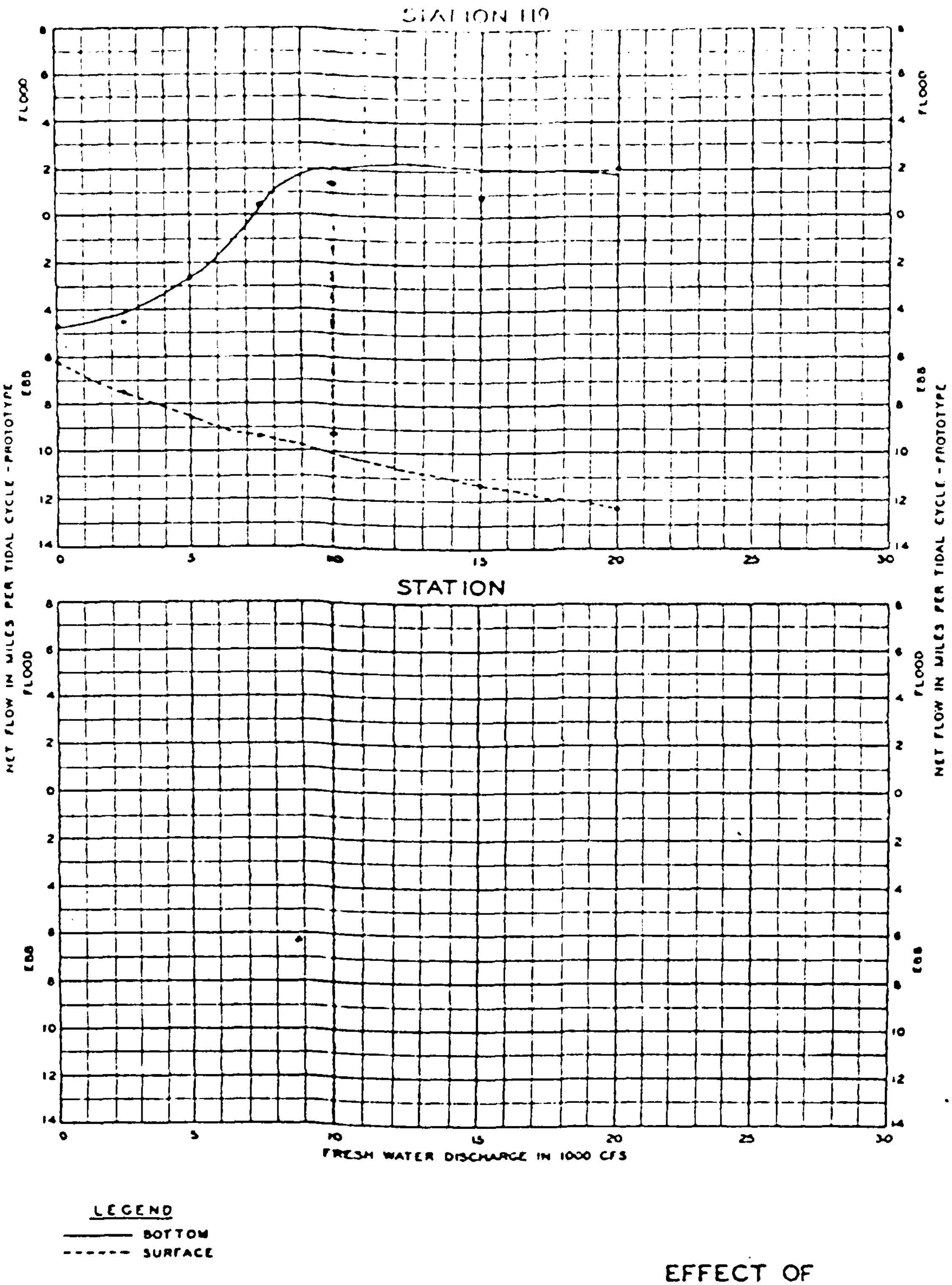
FIGURE 13



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A
Page 23 of 28

FIGURE 14



EFFECT OF
FRESH-WATER DISCHARGE
ON PREDOMINANCE OF FLOW

EXHIBIT A

FIGURE 15

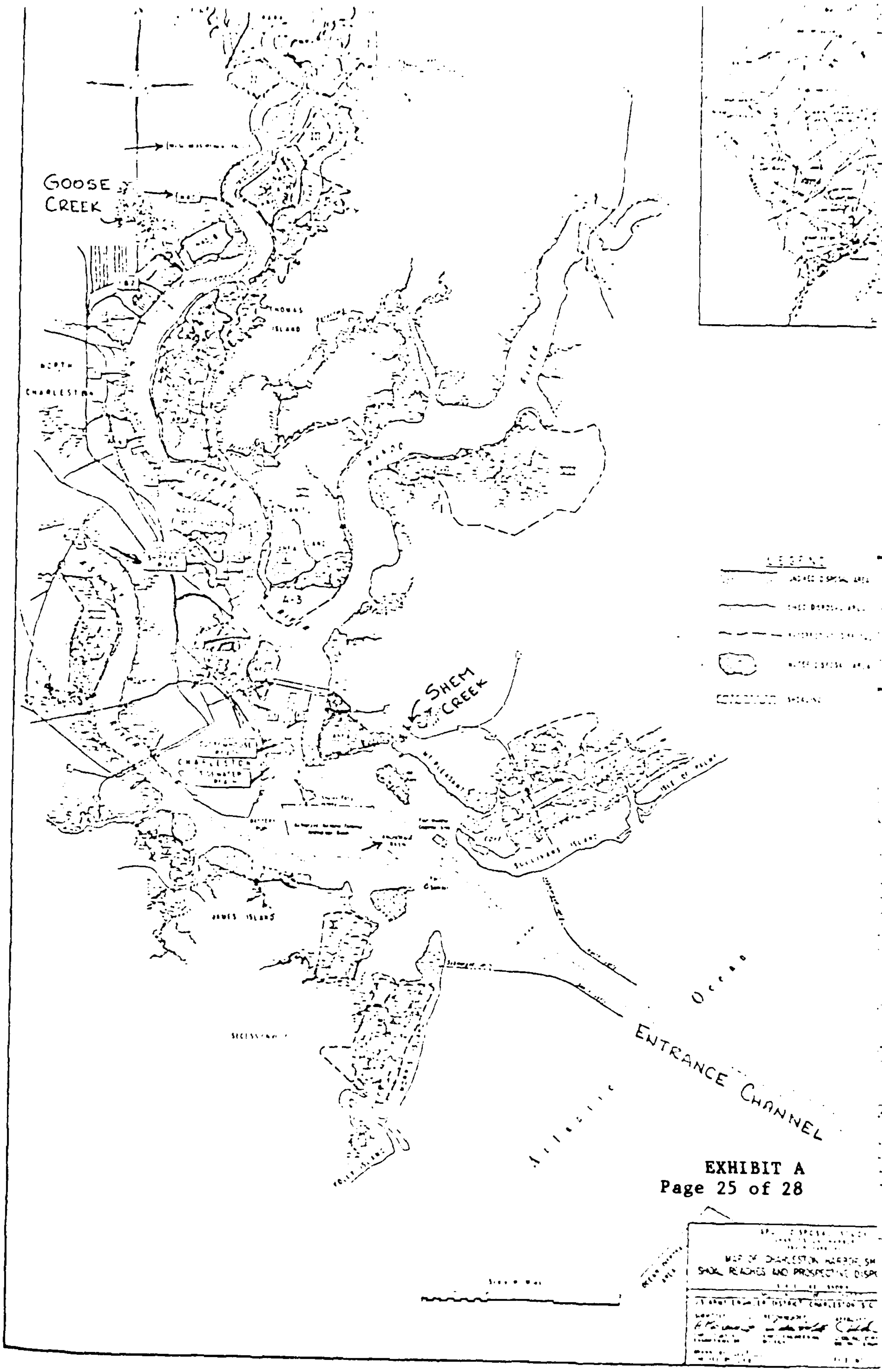
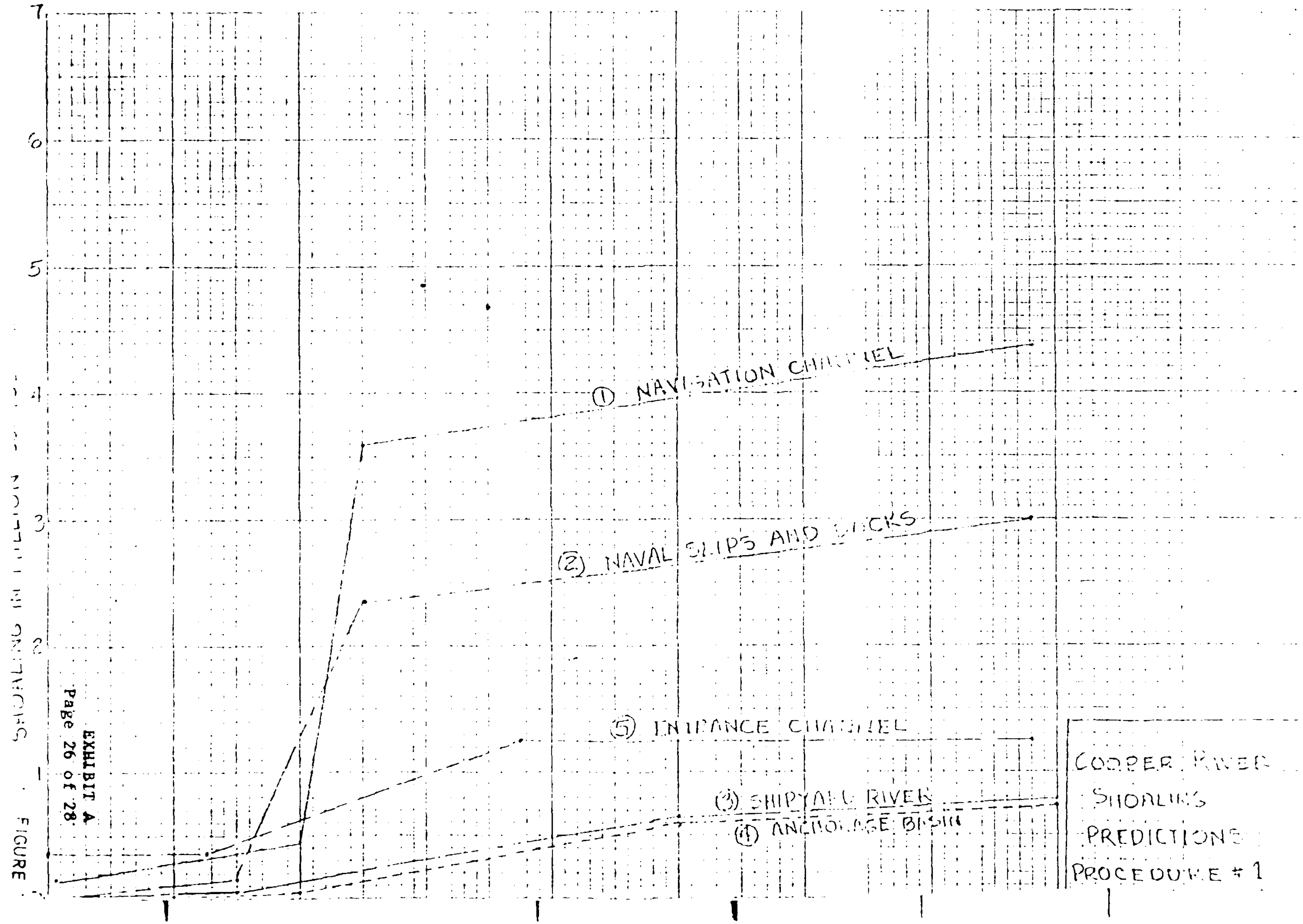
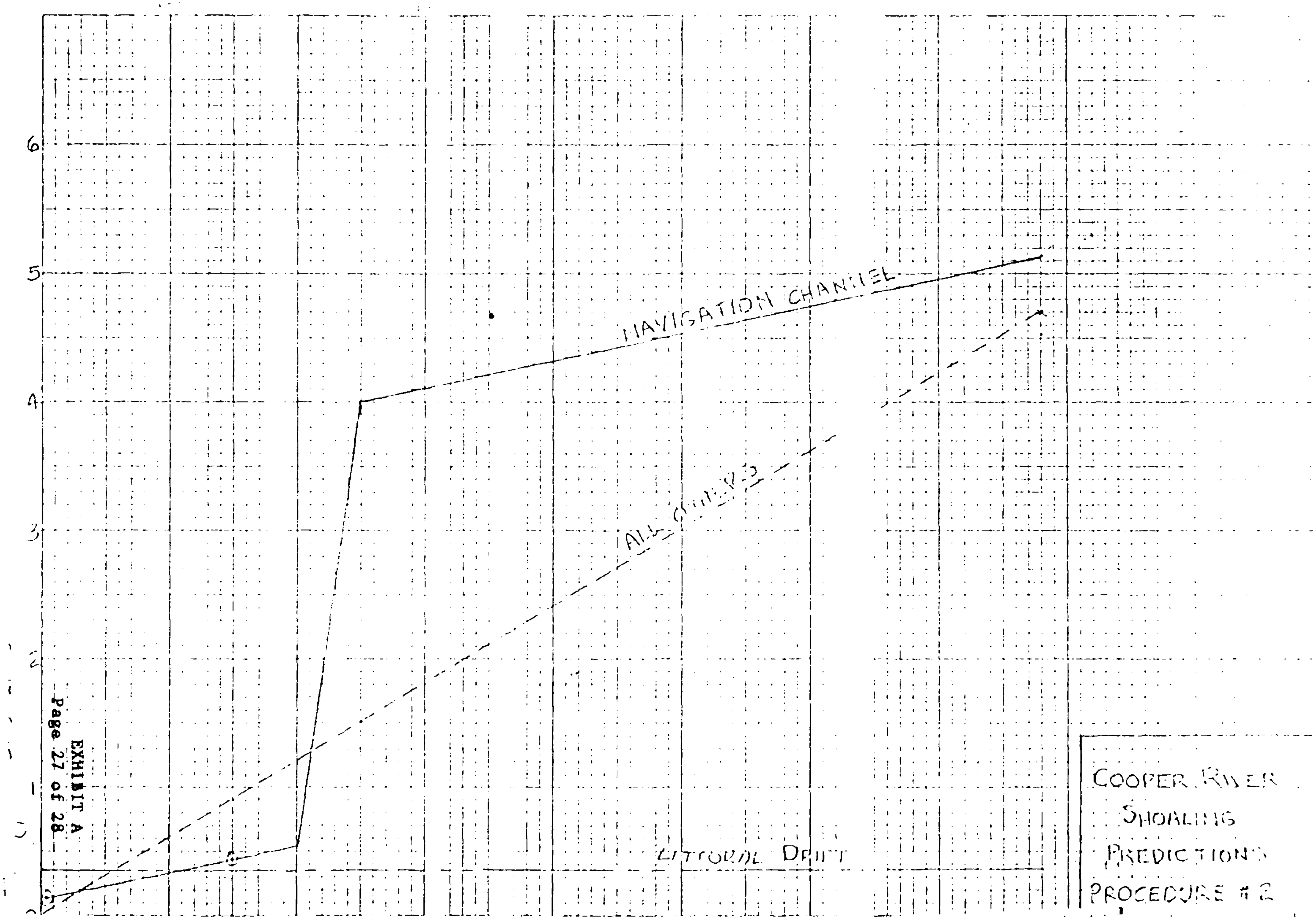


EXHIBIT A
Page 25 of 28

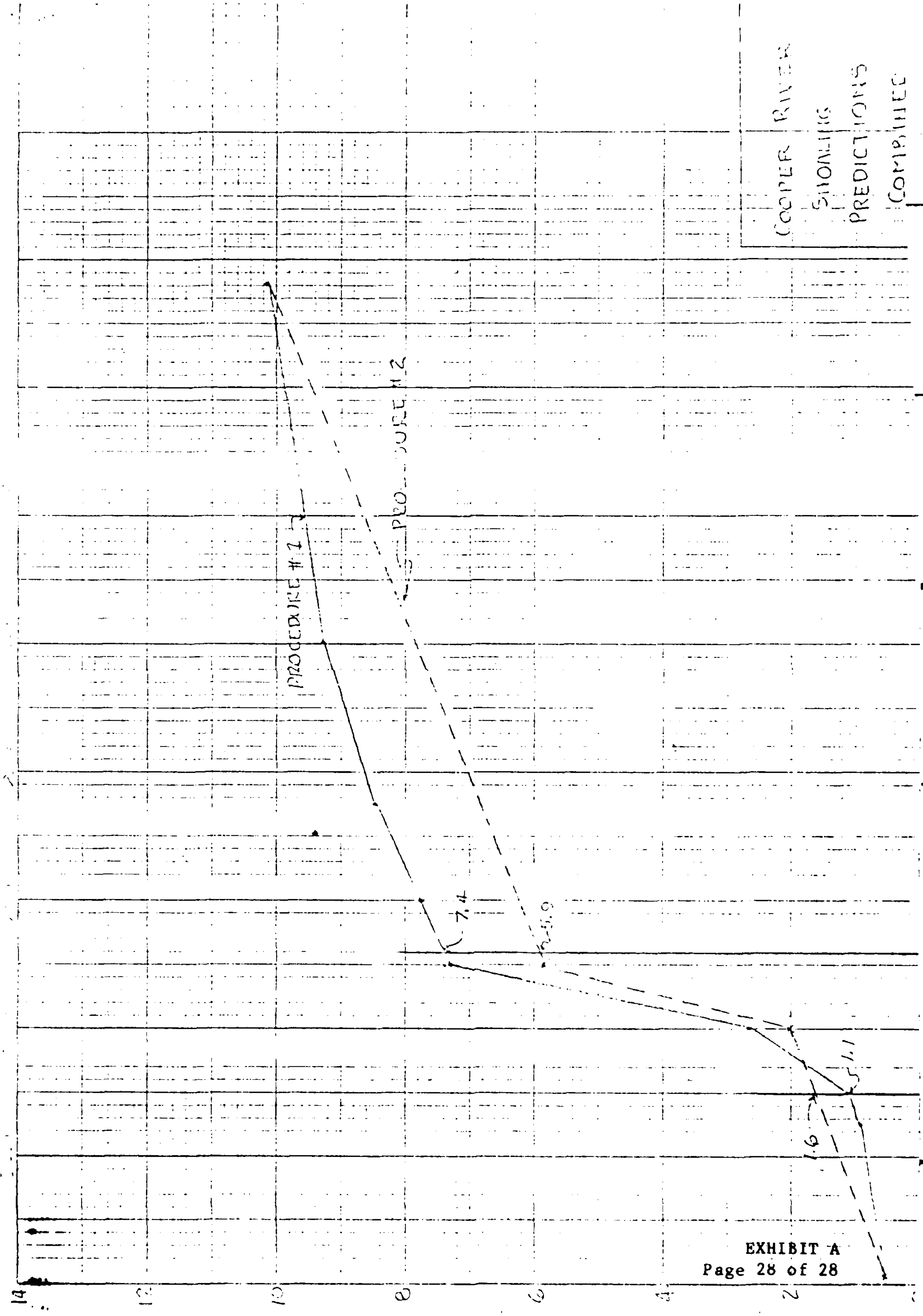


FIGURE

EXHIBIT A
Page 26 of 28



6
5
4
3
2
1
0
NAVIGATION CHANNEL
ALL OTHERS
LITTORAL DRIFT
COOPER RIVER
SHOALING
PREDICTIONS
PROCEDURE # 2


COOPER RIVER
SHOWING
PREDICTIONS
COMBINED
PROCEDURE #1
PRO...DURE #2
7.4
5.9
1.1
1.6
14
12
10
8
6
4
2

2400 PSIG-1000°/1000°F-1.5" HG.A.

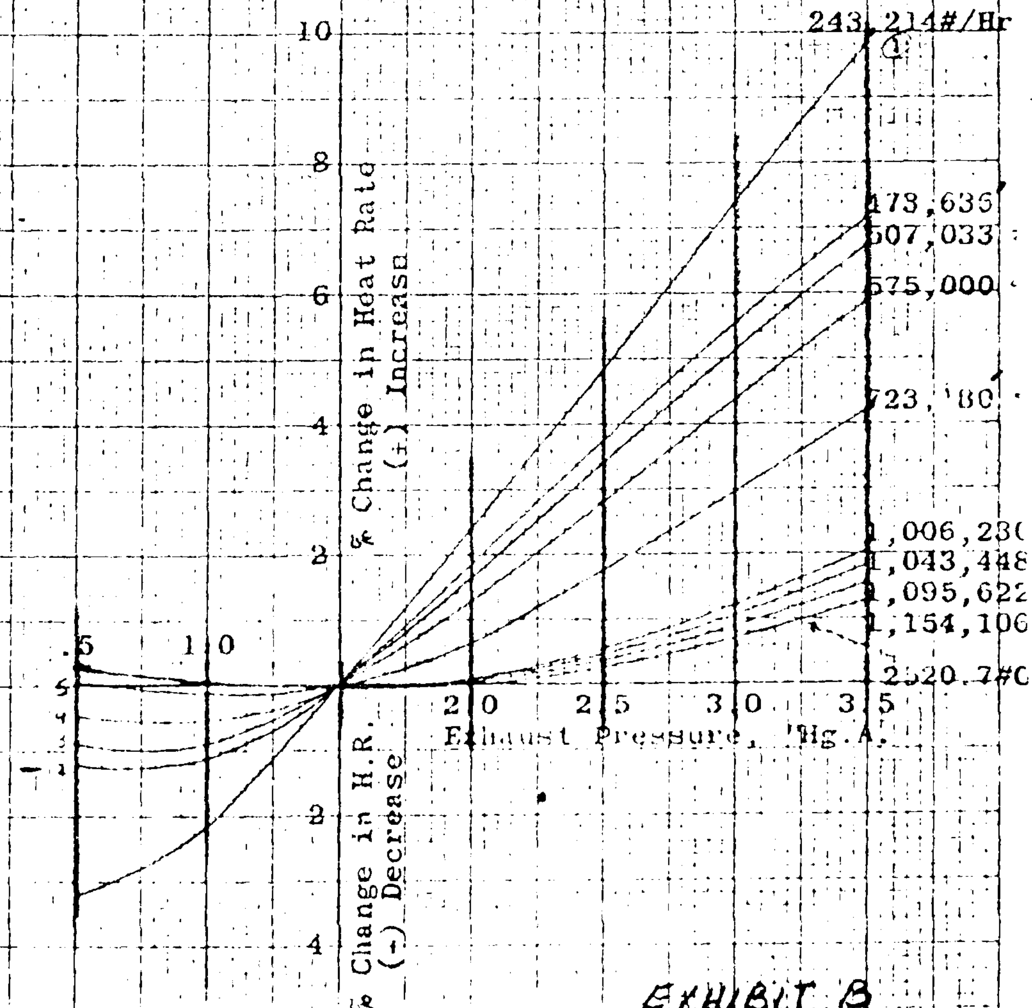
METHOD OF USING CURVE:

Flows near curves are throttle flows.
At 2400 Psig-1000°/1000°F these correction factors assume constant control valve opening and are to be applied to heat rates and KW loads at 2400 Psig-1000°/1000°F-1.5" Hg.Abs.

1. The percent change in KW load for various exhaust pressures is equal to:

$$\frac{(\text{Minus \% Change in Heat Rate})100}{100 + \text{\% Change in Heat Rate}}$$

2. These correction factors are not guaranteed.



P.W.R.
8/12/66

EXHIBIT B
Page 1 of 2

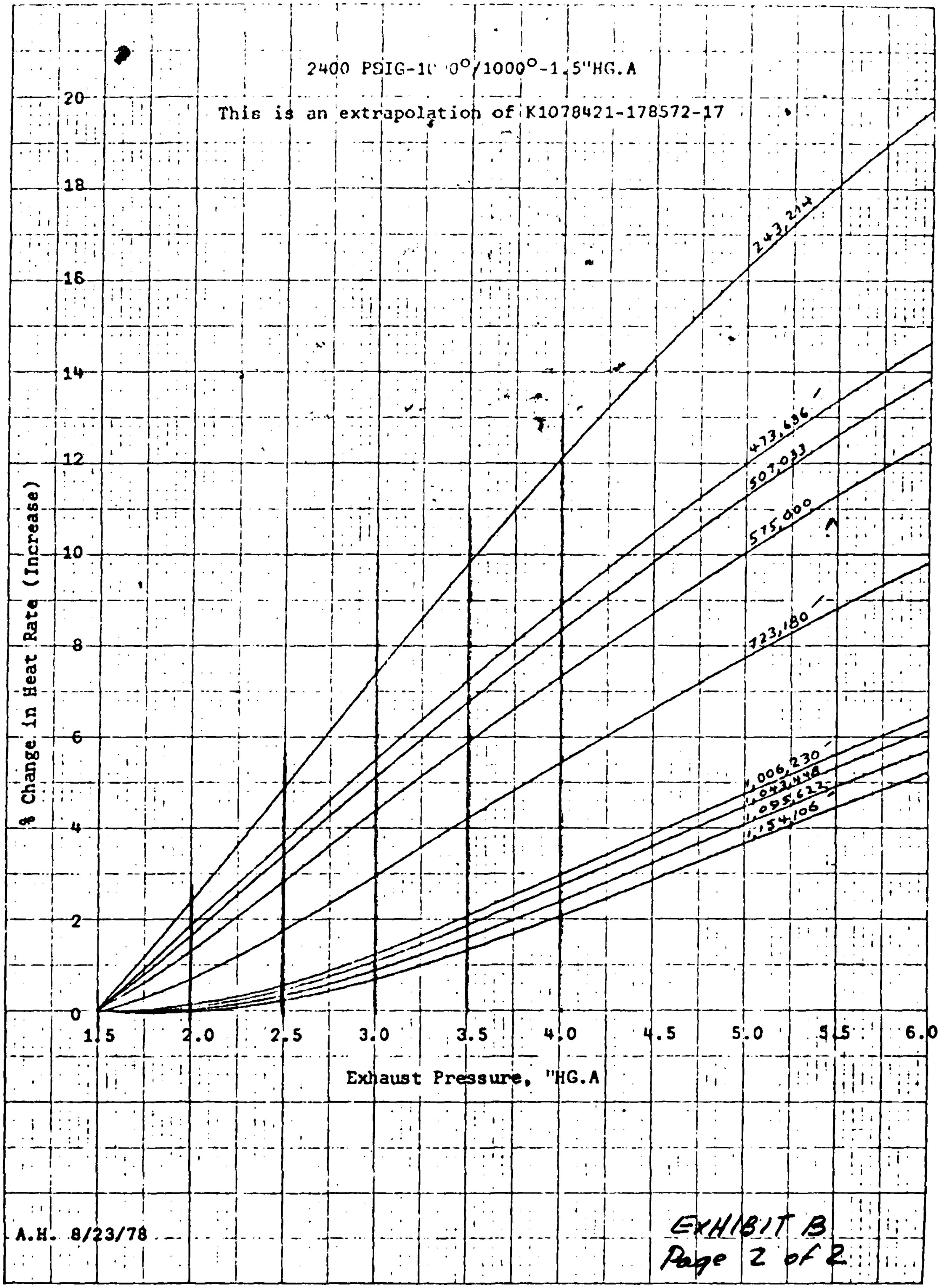


EXHIBIT B
Page 2 of 2

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

EXHIBIT C

SCHEMATIC AND LAYOUT SKETCH
OF ALTERNATIVES ANALYZED

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

DESIGNED BY B. RICHARDSON	DATE 2/27/78	SHEET NO. 1		PAGE NO.	
CHECKED BY R.A. MAYS	DATE 10/12/78	OF 1		JOB NO. 7288-02	
REVIEWED BY	DATE	SUBJECT:	CIRCULATING WATER SCHEMATIC		
APPROVED BY	DATE		COOLING TOWER ALTERNATIVE		

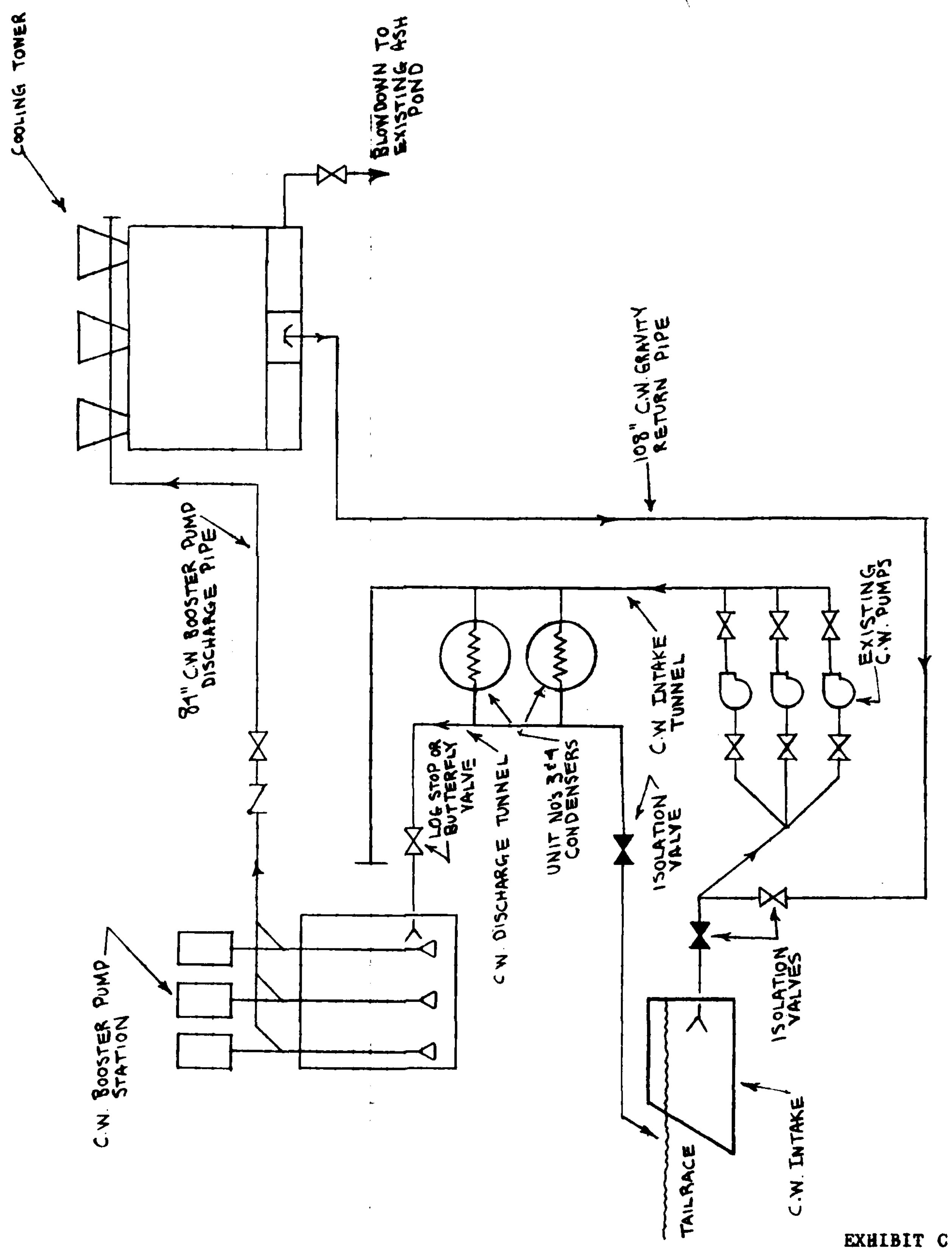


EXHIBIT C
Page 1 of 6

DESIGNED BY	R. RICHARDSON	DATE	9/27/78	SHEET NO.	PAGE NO.
CHECKED BY	RAM	DATE	10/12/78	OF	JOB NO. 7288-02
REVIEWED BY		DATE		SUBJECT:	PLANT SITE LAYOUT
APPROVED BY		DATE			COOLING TOWER ALTERNATIVE

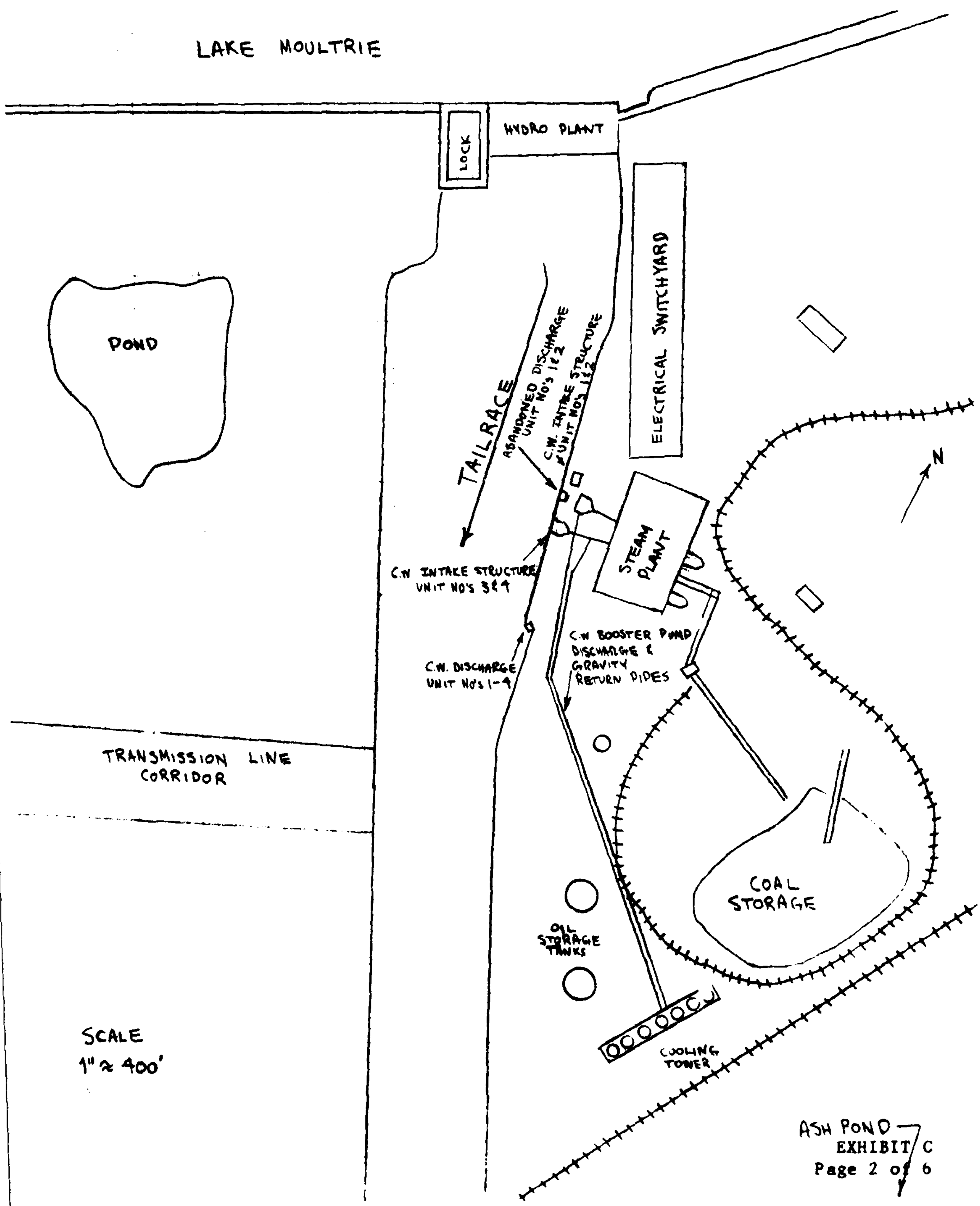
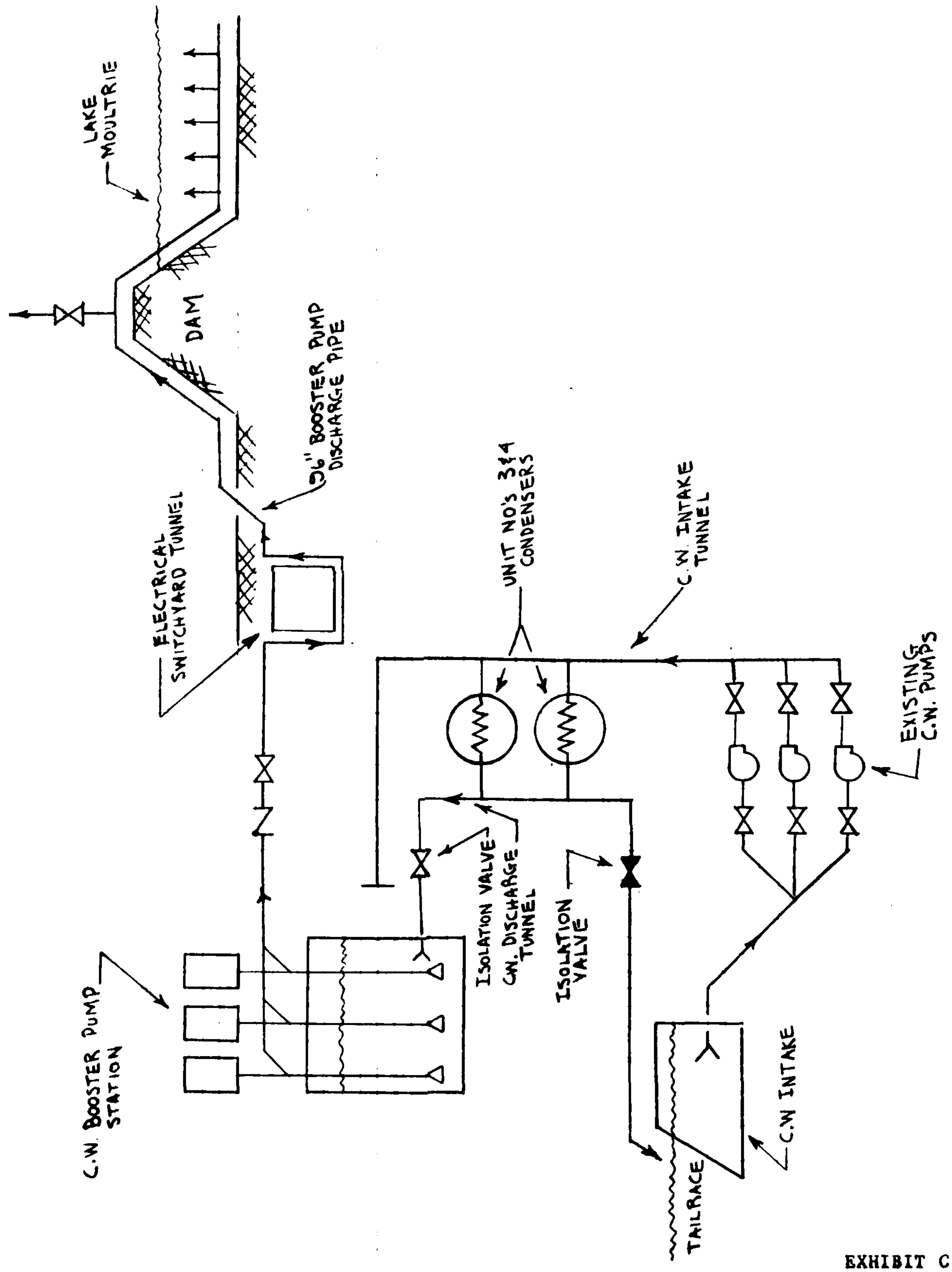


EXHIBIT C
Page 2 of 6

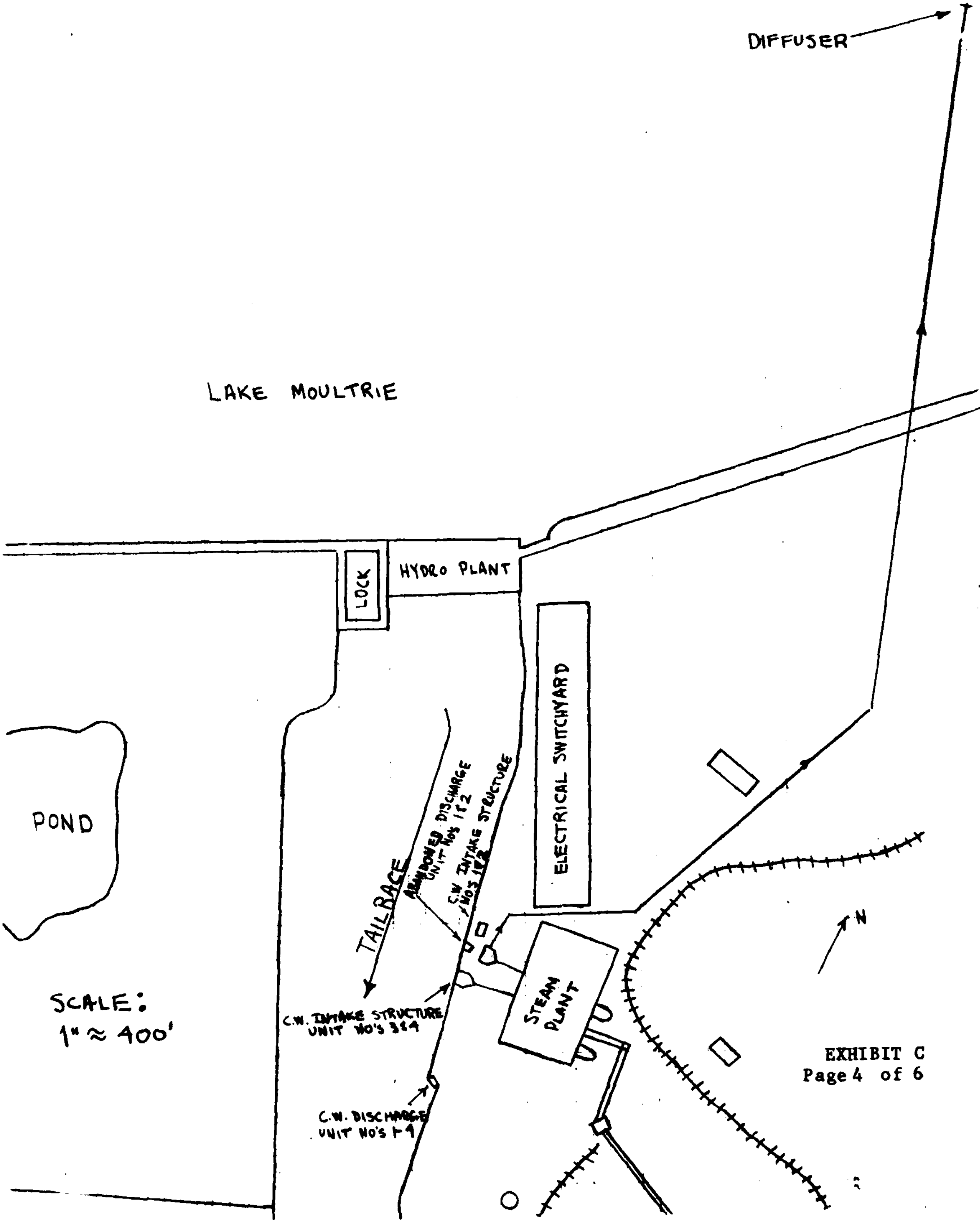
DESIGNED BY B. RICHARDSON	DATE 9/28/78	SHEET NO. 1	PAGE NO.
CHECKED BY RA MAYS	DATE 10/12/78	OF 1	JOB NO. 7288-02
REVIEWED BY	DATE	SUBJECT: CIRCULATING WATER SCHEMATIC	
APPROVED BY	DATE	PUMP-BACK ALTERNATIVE	



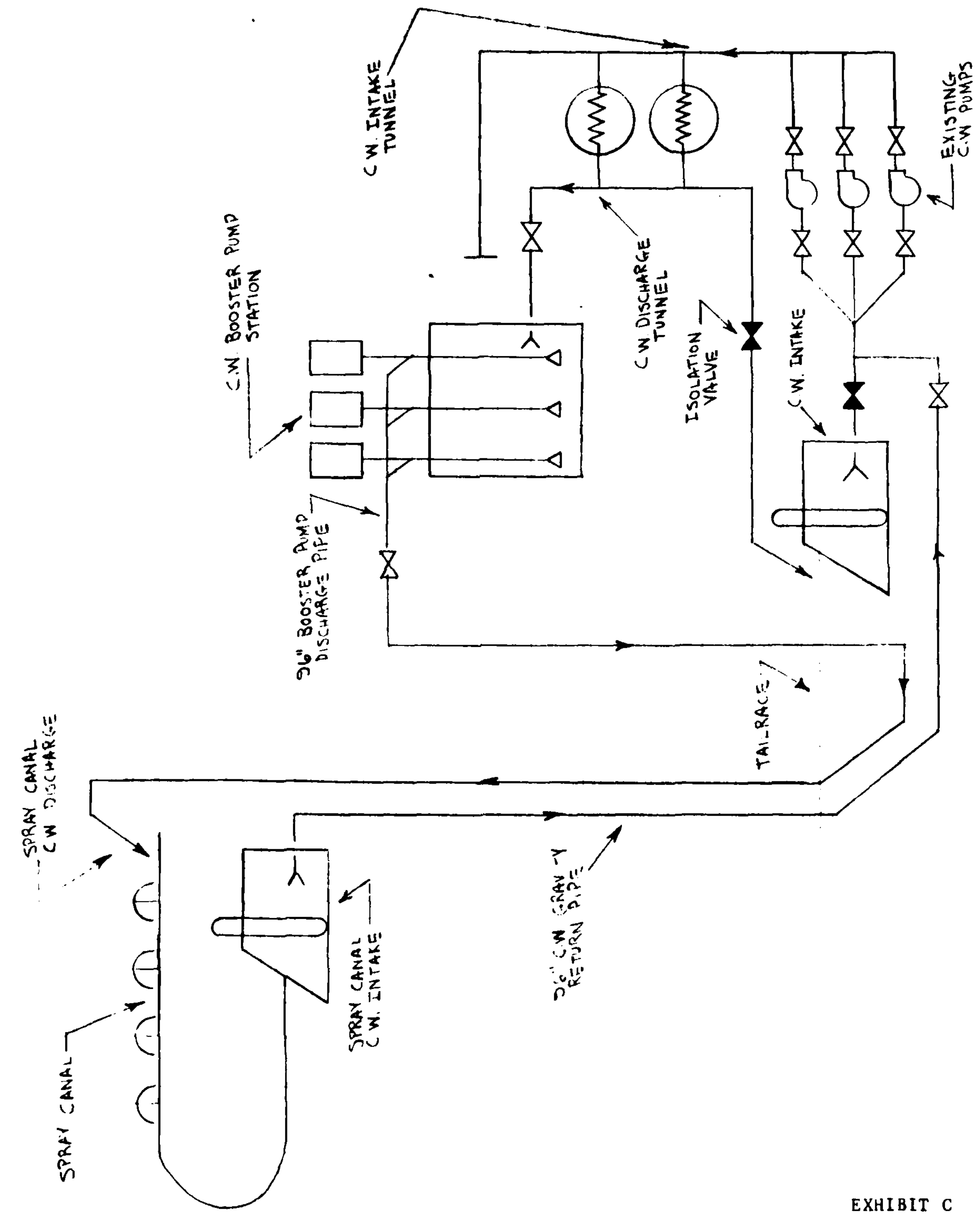
[redacted] CHECKED BY .... DATE .... OF .... JOB NO. ....

REVIEWED BY .... DATE .... SUBJECT: PLANT SITE LAYOUT

APPROVED BY .... DATE .... PUMP BACK ALTERNATIVE



DESIGNED BY B. RICHARDSON DATE 10/3/78 SHEET NO. 1 PAGE NO.
CHECKED BY R.A. MAYS DATE 10/12/78 OF 1 JOB NO. 7238-02
REVIEWED BY DATE SUBJECT: CIRCULATING WATER SCHEMATIC
APPROVED BY DATE Spray CANAL ALTERNATIVE



DESIGNED BY B. RICHARDSON	DATE 2/27/78	SHEET NO. 1288-92		PAGE NO.	
CHECKED BY	DATE	OF		JOB NO.	
REVIEWED BY	DATE	SUBJECT: PLANT SITE LAYOUT			
APPROVED BY	DATE	SPRAY CANAL ALTERNATIVE			

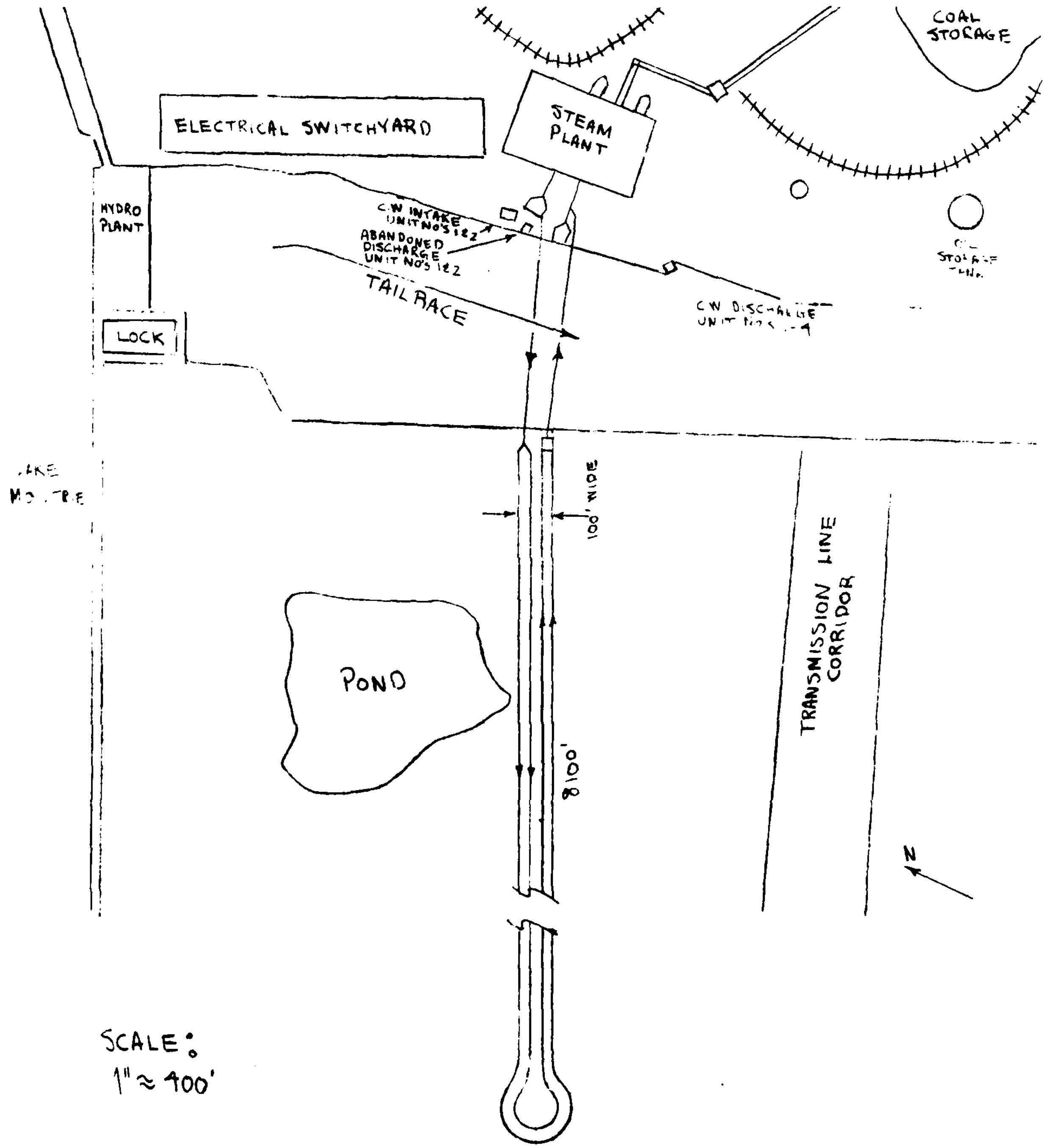


EXHIBIT C
Page 6 of 6

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

EXHIBIT D

LETTERS FROM STATE AGENCIES

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

Resources Department

James A. Timmerman, Jr., Ph.D.
Executive Director
Jefferson C. Fuller, Jr.
Director of
Wildlife and Freshwater Fisheries

January 10, 1979

Mr. Jack J. Lesemann, Chief, Engineering Division
Charleston District, Corps of Engineers
P. O. Box 919
Charleston, South Carolina 29402

Dear Mr. Lesemann:

This is in reference to the proposed water cooling system for the Jefferies Steam Power Plant at Pinopolis.

Of the three plans proposed by the Corps, the pump-back method and the spray system would impact the aquatic environment to some extent. Without more information, there is no way to predict how major or minor the impact will be. Since the cooling tower scheme would not impact the aquatic environment, then I feel it is our responsibility to request that the Corps consider this alternative.

The pump-back scheme, which is apparently the Corps' #1 choice, would be located near the Pinopolis Dam which is probably one of the more popular fishing areas. Mention is made of this since additional costs would be tacked on to the original estimate for possible relocation of the heated affluent.

If the Corps pursues the pump-back method, then we will require additional data which could require a model for more accurate predictions of any adverse impacts on the environment.

I know of no way the aquatic environment would benefit by any of the three plans, therefore, can make no pro comments.

Yours truly,

Jefferson C. Fuller, Jr.
Director, Division of Wildlife and
Freshwater Fisheries

JCFjr:bc

EXHIBIT D
Page 1 of 3

BOARD

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

Albert G. Randall, M.D., M.P.H.
Commissioner

Sims Aycock Buildings
2600 Bull Street Columbia, SC 29201

January 12, 1979

Mr. Jack J. Leseman
Chief, Engineering Division
Department of the Army
Corps of Engineers
P. O. Box 919
Charleston, S. C. 29402

Dear Mr. Leseman:

We would like to take this opportunity to thank you and your staff for allowing us to advise the Corps on our areas of concern pertaining to the effects of th .ediversion Project on the Jeffries Steam Plant at Pinopolis Dam. Therefore, in response to your letter of December 22, 1978, this office makes the following comments on the three proposals for handling the circulating cooling water for the Jeffries Plant.

1. Mechanical Draft Cooling Tower - This means of cooling is by far the most acceptable since it will have the least amount of environmental impact; specifically, the aquatic environment. The consumptive losses due to the towers could be as high as 29 cfs which is less than 1 percent of the flow in the Tailrace Canal experienced after rediversion.

2. Pump Back Method - This method of cooling is by far the least acceptable since it is suspected to have the greatest potential impact. The point of discharge and its affected area appears to be immediately above the dam which is the access point to Lake Moultrie for migrating species of aquatic organisms. The impact on these organisms is of major concern and would require extensive documentation as to the extent of the impact. As you are aware, there are many communities of aquatic species, especially the striped bass community, in this lake system which are very valuable to the State of South Carolina; therefore, any adverse impact placed on these communities is of great concern and must be assessed very carefully. Monitoring requirements are expected to be extensive both before and after the discharge begins in order to verify projected impacts. Furthermore, the findings of studies which are conducted to predict the impact may show that this method of cooling is unacceptable.

wo

As you know, a much more detailed analysis of the thermal plume would be needed on which to base a final decision. The plume must be predicted under worst case conditions and at different seasons of the year.

3. Spray System - This method would have a minimal thermal impact on the aquatic environment and is more acceptable than the pump back method. However, the land area needed for a spray pond or a spray canal would more than likely include wetlands which would require additional permits.

In summary, the cooling tower method is the most acceptable from a water quality viewpoint and would require no field documentation and much less monitoring evaluation prior to and during the life of the permit.

If you have any additional questions or comments, please advise.

Sincerely,

Charles R. Jeter, P.E., Chief
Bureau of Wastewater & Stream Quality Control

CRJ/JWP/bk

CC: Joe Logan - Wildlife & Marine Resources
Howard Zeller - EPA, Atlanta

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

EXHIBIT E

OPTIMIZATION OF COOLING TOWER DESIGN

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

DESIGNED BY Burn DATE 1/11/80 SHEET NO. PAGE NO.
CHECKED BY DATE OF JOB NO. 7288-03
REVIEWED BY DATE SUBJECT: MECHANICAL DRAFT TOWER
APPROVED BY DATE APPROACH OPTIMIZATION

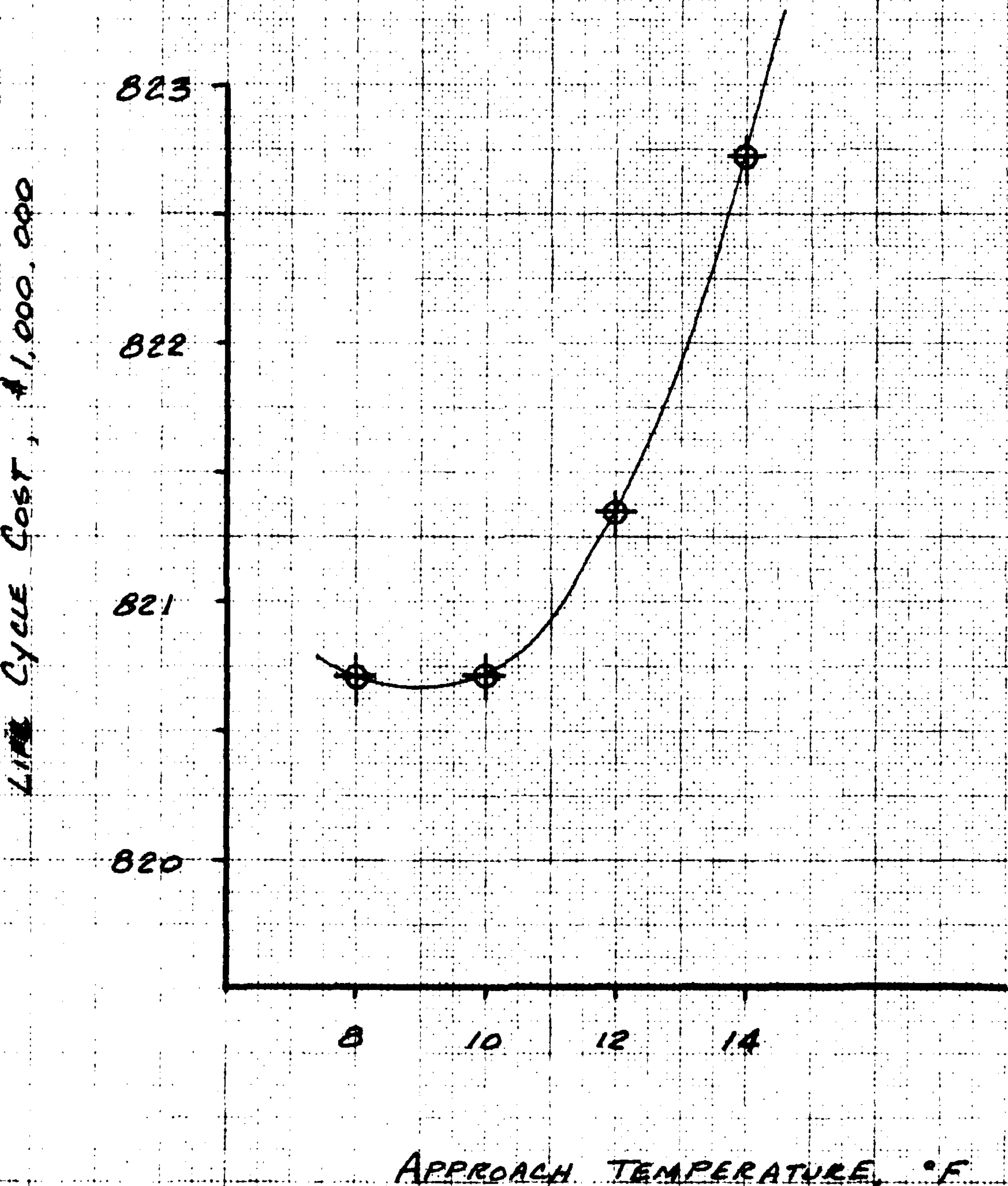


EXHIBIT E
Page 1 of 6

CORPS OF ENGINEERS
MONCKS CORNER, SOUTH CAROLINA

JEFFRIES STEAM PLANT

ECONOMIC STUDY OF
CONDENSER - COOLING TOWER CHARACTERISTICS

DESIGN WET BULB T	79.00	TUBE CLEANLINESS FACTOR	0.850
APPROACH TO WET BULB T	10.00	TUBE MATERIAL AND BWG	0-ADMIR-18
CIRC WATER FLOW, GPM	159000.	TUBE OD, IN.	1.000
NUMBER OF PASSES	2.	TUBE MATERIAL FACTOR	1.000
WATER VELOCITY THRU TUBES	7.000		

DESIGN PARAMETERS

COND SRFC AREA SQ FT	180000.
NUMBER OF TUBES	22808.
TUBE LENGTH,FT	30.14

PERFORMANCE

MAX COND PRESS, IN HGA	2.817
TURBINE CAPABILITY AT MAX EXH PRESS, KW	334198.
COND CW HEAD LOSS, FT	16.85
TOTAL BHP REQUIRED	4608.
TOTAL DEMAND, KWE	3712.
TOTAL ENERGY, KWHR PER YEAR	20799458.

ANNUAL OPERATING COSTS, DOLLARS PER YEAR

FUEL TO BOILER	52873350.
TOTAL ENERGY	695313.

INVESTMENT, DOLLARS

CONDENSER	0.
CW PUMPS AND MOTORS	0.
COOLING TOWER	6000000.
TOTAL	6000000.

LIFE CYCLE COSTS, DOLLARS

INVESTMENT	5184000.
FUEL	795532438.
ELECTRICAL ENERGY	10461685.
TURBINE CAPABILITY	3044976.
ELECTRICAL DEMAND	6504433.
TOTAL	820727532.

JOB NO. 7288-03-439

STANLEY CONSULTANTS
MUSCATINE, IOWA

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

EXHIBIT F

COORDINATION WITH
SOUTH CAROLINA PUBLIC SERVICE AUTHORITY

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

CORPS OF ENGINEERS
MONCKS CORNER, SOUTH CAROLINA

JEFFRIES STEAM PLANT

ECONOMIC STUDY OF
CONDENSER - COOLING TOWER CHARACTERISTICS

DESIGN WET BULB T	79.00	TUBE CLEANLINESS FACTOR	0.850
APPROACH TO WET BULB T	8.00	TUBE MATERIAL AND BWG	0-ADMIR-18
CIRC WATER FLOW, GPM	159000.	TUBE OD, IN.	1.000
NUMBER OF PASSES	2.	TUBE MATERIAL FACTOR	1.000
WATER VELOCITY THRU TUBES	7.000		

DESIGN PARAMETERS

COND SRFC AREA SQ FT	180000.
NUMBER OF TUBES	22808.
TUBE LENGTH,FT	30.14

PERFORMANCE

MAX COND PRESS, IN HGA	2.664
TURBINE CAPABILITY AT MAX EXH PRESS, KW	354653.
COND CW HEAD LOSS, FT	16.85
TOTAL BHP REQUIRED	4837.
TOTAL DEMAND, KWE	3898.
TOTAL ENERGY, KWHR PER YEAR	21636458.

ANNUAL OPERATING COSTS, DOLLARS PER YEAR

FUEL TO BOILER	52824186.
TOTAL ENERGY	723293.

INVESTMENT, DOLLARS

CONDENSER	0.
CW PUMPS AND MOTORS	0.
COOLING TOWER	6900000.
TOTAL	6900000.

LIFE CYCLE COSTS, DOLLARS

INVESTMENT	5961600.
FUEL	794792704.
ELECTRICAL ENERGY	10882679.
TURBINE CAPABILITY	2247816.
ELECTRICAL DEMAND	6830305.
TOTAL	820715104.

JOB NO. 7288-03-433

STANLEY CONSULTANTS
MUSCATINE, IOWA

Once-thru Cooling

CORPS OF ENGINEERS
MONCKS CORNER, SOUTH CAROLINA

JEFFRIES STEAM PLANT

ECONOMIC STUDY OF
SURFACE CONDENSER CHARACTERISTICS

NUMBER OF PASSES	2.	TUBE MATERIAL AND BWG	0-ADMIR-18
WATER VELOCITY THRU TUBES	7.000	TUBE OD, IN.	1.000
TUBE CLEANLINESS FACTOR	0.850	TUBE MATERIAL FACTOR	1.000

CONDENSER SURFACE AREA, SQ.FT. 180000.

DESIGN PARAMETERS

CIRC WATER FLOW, GPM	159000.
NUMBER OF TUBES	22808.
TUBE LENGTH,FT	30.14

PERFORMANCE

MAX COND PRESS, IN HGA	2.817
TURBINE CAPABILITY AT MAX EXH PRESS, KW	334198.
COND CW HEAD LOSS, FT	15.75
CW PUMP BHP REQUIRED	739.
CW PUMP DEMAND, KWE	589.
CW PUMP ENERGY, KWHR PER YEAR	3539770.

ANNUAL OPERATING COSTS, DOLLARS PER YEAR

FUEL TO BOILER	52908448.
ENERGY TO CW PUMPS	118332.

INVESTMENT, DOLLARS

CONDENSER	0.
CW PUMPS AND MOTORS	0.
TOTAL	0.

LIFE CYCLE COSTS, DOLLARS

INVESTMENT	0.
FUEL	796060515.
ELECTRICAL ENERGY,	1780429.
TURBINE CAPABILITY,	3044589.
ELECTRICAL DEMAND,	1033612.
TOTAL	801919146.

JOB NO. 7288-03-433

STANLEY CONSULTANTS
MUSCATINE, IOWA

William C. Mescher
President and Chief Executive Officer

August 11, 1980

LTC Bernard E. Stalmann
U. S. Army, Corps of Engineers
Charleston District Corps of Engineers
Post Office Box 919
Charleston, SC 29402

Dear Colonel Stalmann:

This is in answer to your letter of 14 July 1980 regarding additional flows thru the Pinopolis Power House to supply cooling water for Jefferies Steam Units #1 and/or #2 as necessitated by the Cooper River Rediversion Project.

The present contract between the Authority and the Government, as negotiated in connection with this project, allows the Authority to use an average flow of 3000 c.f.s. thru the hydro plant in such a manner as to obtain flexibility in operation and also utilize its entire capability. We do not wish to change the provisions of the present contract to restrict this flexibility.

Your letter sets forth an additional amount of flow thru the hydro plant to be used for cooling water for Jefferies Steam Units #1 and #2. You advise that cooling for Jefferies Steam Units #3 and #4 is to be taken care of by closed loop cooling tower.

From your letter we deduce that you are willing to allow passage thru the hydro plant of an average amount of 2300 c.f.s. for the cooling of Jefferies Units #1 and/or #2. This amount of discharge would be allowable when Jefferies Units #1 and/or #2 are operating and sufficient water is not being discharged thru the hydro plant in accordance with the present agreement to take care of the cooling requirements of these units. It is our feeling that this average flow of 2300 c.f.s. per hour is adequate to cover the cooling requirements for Units #1 and #2. However, we prefer that the amendment to the contract state that this amount of discharge is for cooling and not to be intermingled with the discharge for normal operations of the hydro plant (3000 c.f.s.).

We look forward to receiving the amendment to the contract and, if you feel that we are not in agreement as to your proposal for operation, we will be glad to receive several scenarios indicating the various modes of operation which you envision. Also, we would like to have the design drawings covering the cooling tower for Units 3 and 4.

Sincerely,

William C. Mescher
President

223 N. LIVE OAK DRIVE, MONCKS CORNER, S.C. 29461 803/899-2121

Santee Cooper
SOUTH CAROLINA PUBLIC SERVICE AUTHORITY

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

EXHIBIT G

IMPLEMENTATION PLAN

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

1980

Time (Months) 0 2 4

Contract #1
Cooling Tower and Basin — Plans + Specs — Adv + Awar

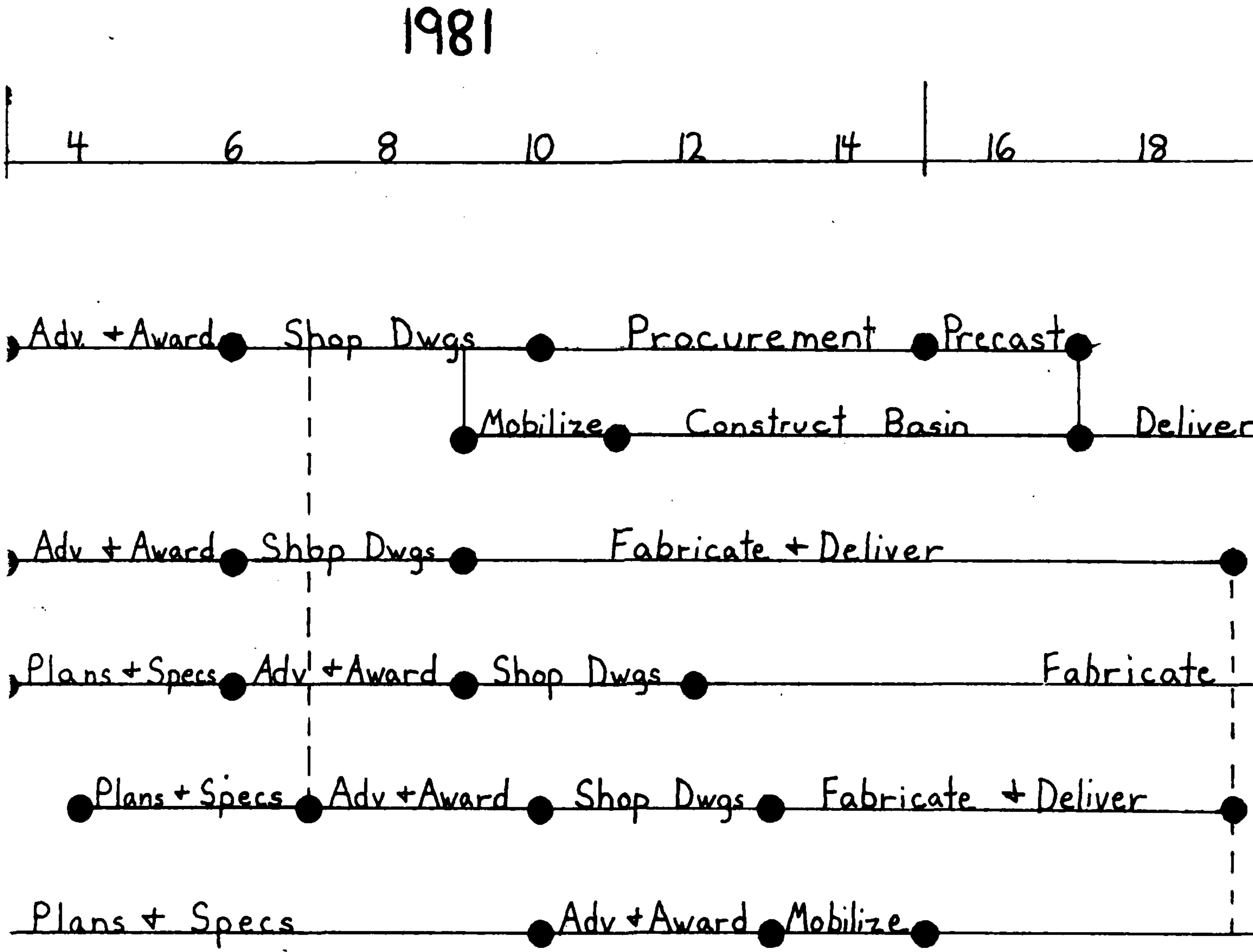
Contract #2
84" + 96" Valves — Plans + Specs — Adv + Awar

Contract #3
53,000 gpm Pumps + Motors — Plans + Spe

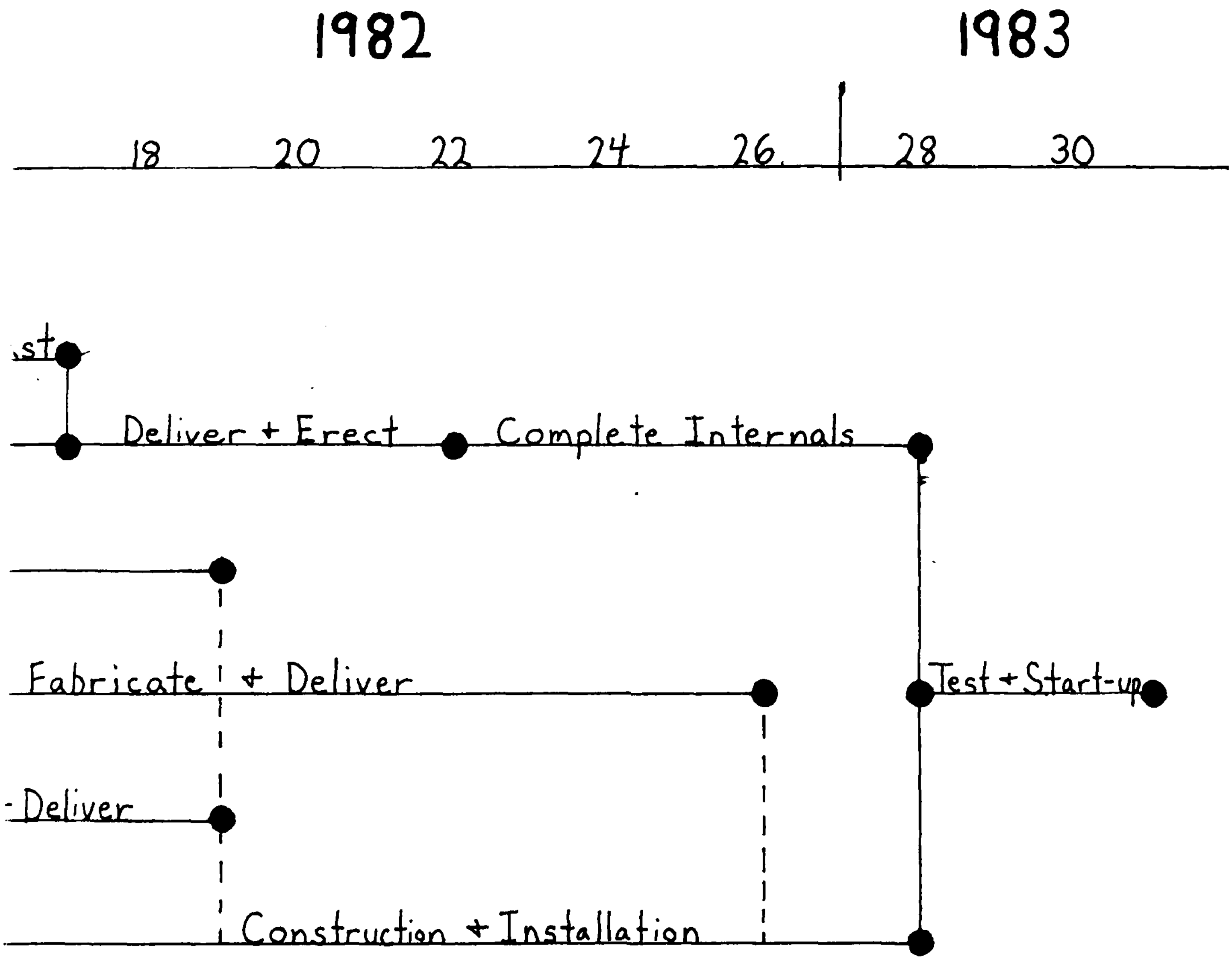
Contract #4 Major Pipe — Plans +

Contract #5
General Construction — Plans +

gcv


1981
4
6
8
10
12
14
16
18
Adv. + Award
Shop Dwgs
Procurement
Precast
Mobilize
Construct Basin
Deliver
Adv + Award
Shop Dwgs
Fabricate + Deliver
Plans + Specs
Adv + Award
Shop Dwgs
Fabricate
Plans + Specs
Adv + Award
Shop Dwgs
Fabricate + Deliver
Plans + Specs
Adv + Award
Mobilize

2



Implementation Plan
Cooling Water Facilities
Cooper River Rediversion Project

EXHIBIT G
Sheet 1 of 1

3

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 13

COOLING WATER FACILITIES

EXHIBIT H

SOILS AND FOUNDATION
INVESTIGATION REPORT
AND BORING LOGS

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

COOPER RIVER REDIVERSION PROJECT
COOLING WATER STUDY
COOLING TOWER PILE FOUNDATION

1. The original design intent for the founding of the cooling towers was to utilize a rigid mat. This type of foundation was considered appropriate for the originally proposed wooden cooling towers. Subsequent to this, studies resulted in the decision to use PVC plastic fill concrete cooling towers. The supplier of this unit indicated that the structure could not tolerate significant settlement and that a pile foundation was desired. Manufacturer's data indicates the necessity of 60- and 100-ton pile capacities.

2. Two continuous splitspoon borings are available at the cooling tower site for use in pile evaluation. These borings are CS-4 and CS-5. The borings were reviewed and a conservative design profile was developed. The design profile assumes fat clays of medium consistency and loose silty sands to about elevation +8. These materials are underlain by about 12 feet of dense (N=40± blows/foot) silty sands. The silty sands are in turn underlain by hard fat clays to about elevation -18, where a strata of very dense silty sands are encountered. The very dense silty sands extend to about elevation -50 where limestone occurs. The groundwater table is generally within 8 feet of the ground surface.

3. It is anticipated that the very dense silty sands occurring at about elevation -18 will be the founding formation for the piles. Two types of piles were considered, drilled or auger-cast piles and steel H piles. Both types of piles are small displacement piles. Displacement piles were not considered due to expected problems in penetrating hard fat clay layer. The following specific data is furnished regarding each pile type to be used once the type pile to be installed has been selected.

a. Bearing Piles.

(1) Drilled, augercast, or similar nondisplacement type bearing piles are considered applicable for use at the site. Analyses indicate the following:

Pile Diameter	Pile Length	Founding Elevation	Maximum Allowable Capacity - Tons
12"	50'	-28 msl	30 Tons
12"	55'	-33 msl	35 Tons
18"	50'	-28 msl	45 Tons
18"	55'	-33 msl	70 Tons
18"	69'	-47 msl	90 Tons

The above pile lengths were developed assuming a top of pile elevation of 22 msl. Due to possible drilling disturbance, adhesion of the fat clay layer was ignored; therefore the above allowable bearing values are considered conservative.

(2) Specifications shall include provisions for an initial pile installation and load test to confirm the founding elevation.

b. Combination Bearing and Friction Piles.

(1) Small displacement piles such as steel H-piles were also considered.

Analyses were made assuming a top of pile elevation of 22 msl. Analyses of these piles indicated a considerable contribution to pile capacity by the layer of hard fat clay. Analyses indicate the following based on the utilization of 12HP53 piles:

Pile Length	Founding Elevation (Min.)	Maximum Allowable Capacity - Tons
45'	-23 msl	45
50'	-28 msl	55
53'	-31 msl	60
73'	-51 msl	90*

(2) A test pile should be driven to a minimum elevation of -23 or refusal and load tested. Since some of the materials to be penetrated are dense and hard, pile driving tips or other reinforcement should be utilized. The load test should not be run until after the pile has had an opportunity to "set". A minimum period of 48 hours is suggested. Also, due to the contribution of adhesion to the steel H-pile, it is recommended the load test have provisions for extended time beyond the 24-hour standard period. A maximum hammer energy of about 16,000 ft.-lbs. is recommended to prevent damage to the piles.

*It is questionable whether these H-piles could be driven economically and without damage to the elevation necessary to develop 90 tons. Future experience at nearby sites may provide better basis for judgement, but driven piles may not be feasible. However, for the present, both drilled piers and driven piles should be considered and cost estimates should evaluate both pile types.

AD-A152 041 COOPER RIVER REDIVERSION PROJECT LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA COOLING WATER FACILITIES (U) SAVANNAH DISTRICT CORPS OF ENGINEERS GA 15 OCT 80 2/2

UNCLASSIFIED F/G 13/2 NL

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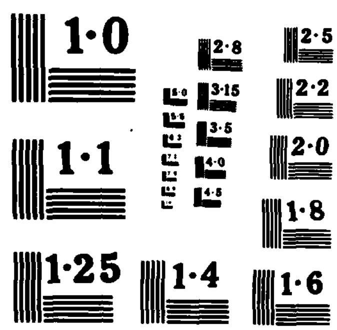

1·0
2·8
2·5
3·15
2·2
3·5
2·0
1·1
4·0
4·5
1·8
1·25
1·4
1·6

FOUNDATION REPORT
COOPER RIVER REDIVERSION PROJECT

COOLING WATER STUDY, JEFFERIES STEAM PLANT

1. GENERAL.

a. This report is prepared by the Foundation and Materials Branch, Savannah District Corps of Engineers. The purpose of the report is to describe foundation conditions and design considerations for inclusion in DM 13. All considerations of this report shall be included in the design and shall be incorporated into the contract plans and specifications.

b. This report is based on data furnished by the designer to the Savannah District. This data described the alignment and approximate depth of pipe trenches and the design loads for the cooling tower and pump station foundations.

2. INVESTIGATIONS.

a. A total of five continuous splitspoon (CS) borings and five auger (A) borings were taken along the alignment of the pipe trench and beneath the proposed cooling tower foundation slab. Borings along the pipe trench alignment were taken to depths sufficient to describe the nature and consistency of materials to be excavated. Borings beneath the cooling tower slab were taken to depths sufficient to determine the founding material characteristics within the zone of influence of the mat and to determine material consistency in the event a pile foundation may have been required. Locations of all borings are shown on Plates 1 & 2, logs of borings are included in this Exhibit.

b. Soil classification and moisture content tests were performed on representative samples obtained from the borings. Soil samples were classified in accordance with the Unified Soil Classification System. A total of thirty-eight samples were tested. As drilling results became available, it became apparent

that a conventional type design could be adopted for the cooling tower foundation. For this reason, no triaxial shear or consolidation tests were performed. Laboratory test results are indicated on the boring logs and test data forms are also contained in this Exhibit.

3. SUBSURFACE CONDITIONS: Borings indicate the on-site materials to be variable and stratified. The upper materials in which structures are founded vary from medium silts, fat clays, and clayey sands to loose silty sands. The groundwater elevation varies from within 3.5 feet of the ground surface in Boring CS-1 to as deep as 19.1 feet in Boring A-5.

4. DESIGN CONSIDERATIONS.

a. Pump Station. The pump station is to be approximately 22 feet deep and have a mat foundation with a gross load of approximately 2.0 k/sf. Analyses indicate the net foundation pressure will actually be about 400psf less than the in situ pressure; therefore, no bearing or settlement problems are anticipated. The water table in the area of the pump station is at depth of approximately 3 feet. The structural design should check the stability of the structure for uplift. During construction, dewatering will be required and the contract specifications should address this necessity. For design of the pump station walls, the following parameters are recommended:

Soil Unit Weight (saturated) - γ = 110pcf

Soil At Rest Earth Pressure - K = 0.7

b. Cooling Tower Foundation.

(1) The cooling towers are proposed to be founded on a mat. The maximum mat contact pressures are on the order of 500 psf. The founding elevation of the mat is a foundation design consideration

(2) Borings CS-4 and CS-5 at the cooling tower site and corresponding laboratory soil classification test data indicate the upper 10 feet of material to

be soft to medium fat clays. Even though the contact pressures are low, consideration of the presence of these materials is warranted.

(3) The size of the mat will produce a potential influence at considerable depth. Since the loads are low, bearing will not be a problem. However, some settlement could occur from the upper soft clays if not addressed. In order to reduce the potential for settlement, it is considered desirable to excavate the area beneath the slab and found the slab at an elevation such that the contact pressure approximates the in-situ pressure prior to the excavation. A minimum depth of excavation 4-5 feet will accomplish this. Further, the site topography and proposed tower configuration is conductive to this procedure. To control settlement, the following procedure is recommended:

(b) The foundation slab should be designed as a rigid mat.

(c) Since the excavation surface is likely to be wet, soft clays, the two foot overexcavation should be backfilled to founding grade with granular material (either sand or gravel) and compacted to at least 95% of standard Proctor density. This will provide a stable working surface.

(4) Groundwater can be anticipated to be a problem at the cooling tower site for the deeper portions of the excavation, though not for the slab portion. The soft wet clays could possibly require excavation by means such as draglines.

(5) Retaining walls for pits shoud be designed for an At-Rest Condition. A horizontal earth pressure coefficient of $K_R = 0.7$ is recommended.

c. Pipe Alignment. Pipe excavation is anticipated to be accomplished by conventional means. Some groundwater control by ditching, sumping, or other means will be required. Shoring will be required unless slopes are laid back to a safe configuration. All excavated material will be satisfactory for backfill except that materials classifying as CH should not be used within 3 feet of the

top of the pipes or beneath areas that will later be paved or support structures.

d. General.

(1) The following materials as classified in the Unified Soil Classification System are satisfactory for use as general site fill and backfill; GW, GP, GM, GC, SW, SP, SM, SC, CL, ML.

(2) The following materials are as classified in the Unified Soil Classification System, unsatisfactory for use as general site fill and backfill: CH, MH, OL, OH, PT.

(3) Backfill beneath the cooling tower slab shall be limited to materials classified in the Unified Soil Classification System as: GW, GP, GM, SW, SP.

(4) All fill and backfill should be compacted to at least 95% of the maximum dry density as determined by the standard compaction test except that the upper 18 inches of fill or backfill beneath paved areas should be compacted to 100% standard density.

(5) The wet site materials will require processing or drying by discing, aerating or other suitable methods in order to allow compaction to specified densities.

(6) The boring logs contain both visual and laboratory classification data. When there is an inconsistency between the two, the laboratory classification takes precedence.

(7) Boring logs indicate the presence of quantities of materials classified as CH. These materials will have to be wasted or used in areas of non-structural fill or backfill such as landscape areas. Some satisfactory borrow may be required unless cooling tower excavations produce a surplus of satisfactory materials.

Hole No. A-1

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Moncks Corner, SC	SHEET 1 OF 1 SHEETS
1. PROJECT Cooling Water Facilities Jefferies Steam Plant		10. SIZE AND TYPE OF BIT 4" Square Auger	
2. LOCATION (Coordinates or Station) See Plan		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Savannah District		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314	
4. HOLE NO. (As shown on drawing title and file number)	A-1	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 7 / UNDISTURBED 0
5. NAME OF DRILLER T. W. Scott		14. TOTAL NUMBER CORE BOXES	
		15. ELEVATION GROUND WATER	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.		16. DATE HOLE	STARTED 18 May 79 / COMPLETED 18 May 79
		17. ELEVATION TOP OF HOLE +25.0' MSL	
7. THICKNESS OF OVERBURDEN	15.0'	18. TOTAL CORE RECOVERY FOR BORING	%
8. DEPTH DRILLED INTO ROCK	0.0'	19. SIGNATURE OF INSPECTOR	
9. TOTAL DEPTH OF HOLE	15.0'	ROBERT V. O'KELLEY, Geologist	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
25.0	0					
24.5			Asphalt			
23.2			SM - Brown, silty, slightly clayey sand with rock fragments and pebbles		1	
22.3					2	W. T. 10.2' Date 18 May 79 Depth to water during drilling.
21.0			Reddish brown mottled with light gray		3	
	5		ML - Brownish green, clayey slightly fine sandy silt		4	
			SM - Brown, very slightly clayey, silty, fine to medium sand			W. T. 9.9' Water table reading 17 hrs. after hole completed.
16.0						
	10		ML - Light green, slightly fine sandy, slightly micaceous, very slightly clayey silt		5	
					6	
					7	
10.0	15					
			Bottom of Boring 15.0'			
			NOTE: Soils field classified in accordance with the Unified Soil Classification System.			

PRELIMINARY
SUBJECT TO CORRECTION

Hole No. A-2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Moncks Corner, SC	SHEET 1 OF 1 SHEETS
1. PROJECT Cooling Water Facilities Jefferies Steam Plant		10. SIZE AND TYPE OF BIT 4" Square Auger	
2. LOCATION (Coordinates or Station) See Plan		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Savannah District		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314	
4. HOLE NO. (As shown on drawing title and file number)	A-2	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 6 / UNDISTURBED 0
5. NAME OF DRILLER T. W. Scott		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE	STARTED 18 May 79 / COMPLETED 18 May 79
7. THICKNESS OF OVERBURDEN	15.5'	17. ELEVATION TOP OF HOLE	+25.0' MSL
8. DEPTH DRILLED INTO ROCK	0.0'	18. TOTAL CORE RECOVERY FOR BORING	%
9. TOTAL DEPTH OF HOLE	15.5'	19. SIGNATURE OF INSPECTOR ROBERT V. O'KELLEY, Geologist	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
25.0	0		Asphalt		JAR	
24.8			SM-Reddish brown, silty, fine to medium sand with rock fragments and pebbles		1	
23.0					2	
20.8			ML-Mottled light green to brown, fine sandy, slightly clayey silt with minor mica			W. T. 10.3' Date 18 May 79 Depth to water during drilling.
20.0	5		SM-Grayish green, very slightly clayey, silty fine to medium sand with minor coarse sand		3, 4	W. T. 9.9' Water table reading 15 hrs. after hole completed.
	10		ML-Light green, very slightly fine sandy silt with minor mica and calcarious material			
11.8						
10.5			SM-Dark green, clayey, fine to medium sand with some mica, wood, and other organic material		5	
9.5	15		CL-Gray mottled with brown fine to medium sandy clay		6	
			Bottom of Boring 15.5'			
			NOTE: Soils field classified in accordance with the Unified Soil Classification System.			

PRELIMINARY
SUBJECT TO CORRECTION

Hole No. A-3

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Moncks Corner, SC	SHEET 1 OF 2 SHEETS

1. PROJECT Cooling Water Facilities Jefferies Steam Plant	10. SIZE AND TYPE OF BIT 4" Square Auger
2. LOCATION (Coordinates or Station) See Plan	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Savannah District	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314
4. HOLE NO. (As shown on drawing title and file number) A-3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED 8 — UNDISTURBED 0
5. NAME OF DRILLER T. W. Scott	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED 19 May 79 — COMPLETED 19 May 79
7. THICKNESS OF OVERBURDEN 15.0'	17. ELEVATION TOP OF HOLE 16.8'
8. DEPTH DRILLED INTO ROCK 0.0'	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 15.0'	19. SIGNATURE OF INSPECTOR ROBERT V. O'KELLEY, Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		SM-Reddish brown, slightly clayey, fine to medium sand with minor rock fragments		1	W. T. 6.8' Date 19 May 79 Depth to water during drilling.
	2		ML-Light greenish brown, slightly clayey, slightly fine sand silt with minor mica and calcarious material		2 3	
			SM-Brown, fine sand, mottled with gray, clayey silt		4	W. T. 4.1' Water table reading 22 hrs. after hole completed.
	4		Gray, slightly clayey, silty fine to medium sand with minor coarse fraction, some mica and a trace of organic material		5	
	6		Clayey		6	
			Light gray, fine to medium, silty sand mixed with clayey silt		7	
	8		Fine to coarse, silty, quartz sand			
	10					
	12		Dark green to green, slightly clayey, silty, fine to medium			

Continued on sheet 2

PRELIMINARY
SUBJECT TO CORRECTION

DRILLING LOG (Cont Sheet)	TION TOP OF HOLE 16.8'				Hole No. A-3
PROJECT Cooling Water Facilities Jefferies Steam Plant		INSTALLATION Moncks Corner, SC			SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	14		Dark green to green, slightly clayey, silty, fine to medium		8	
			Bottom of Boring 15.0'			
			NOTE: Soils field classified in accordance with the Unified Soil Classification System.			

PRELIMINARY
SUBJECT TO CORRECTION

Hole No. A-4

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Moncks Corner, SC	SHEET 1 OF 2 SHEETS

1. PROJECT Cooling Water Facilities Jefferies Steam Plant	10. SIZE AND TYPE OF BIT 4" Square Auger, 4" Spiral Auger
2. LOCATION (Coordinates or Station) See Plan	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Savannah District	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314
4. HOLE NO. (As shown on drawing title and file number) A-4	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED 11 — UNDISTURBED 0
5. NAME OF DRILLER T. W. Scott	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED 20 May 79 — COMPLETED 20 May 79
7. THICKNESS OF OVERBURDEN 44.0'	17. ELEVATION TOP OF HOLE +29.0'
8. DEPTH DRILLED INTO ROCK 0.0'	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 44.0'	19. SIGNATURE OF INSPECTOR ROBERT V. O'KELLEY, Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		ML-Light brown, fine sandy, clayey silt with mica		1	NOTE: 4" square auger used from 0.0' to 12.0' 4" spiral auger used from 12.0' to 51.0'
	5		SM-Mottled brown to gray, clayey, fine to medium sand with mica		2	W. T. 19.1' Date 19 May 79 Depth to water during drilling.
	10		Gray		3	W. T. 19.1' Water table reading 22 hrs. after hole completed.
	15		Dark gray, organic with wood, fine grained		4	
			Mottled grayish brown, brown and gray, moderately micaceous, minor organic material		5	
	20		Light gray, slightly clayey fine to medium grained			
			Silty, not clayey, fine to coarse grained		7	
	25		Dark green to green and gray slightly clayey to clayey, fine to medium grained		8	
			Green, silty vice clayey		9	
	30		MH-Light green, clayey, slightly fine sandy silt with mica		10	

PRELIMINARY
SUBJECT TO CORRECTION

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE +29.0' **Hole No.** A-4

PROJECT Cooling Water Facilities Jefferies Steam Plant | INSTALLATION Moncks Corner, SC | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	32.5		MH-Light green, clayey, slightly fine, sandy silt with mica			
	35					NOTE: Based on other information obtained from additional boring (CS-4) near A-4, apparent top of rock at 44.0' is top of green, loosely cemented marl with some hard limestone inclusions.
	40		SM-Green, slightly clayey silty, fine to medium sand with fragments of gray fossiliferous limestone		11	
			Bottom of Boring 44.0'			

NOTE: Soils field classified in accordance with the Unified Soil Classification System.

PRELIMINARY
SUBJECT TO CORRECTION

Hole No. A-5

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Moncks Corner, SC	SHEET 1 OF 2 SHEETS

1. PROJECT Cooling Water Facilities Jefferies Steam Plant	10. SIZE AND TYPE OF BIT 4" Square Auger, 4" Spiral Auger
2. LOCATION (Coordinates or Station) See Plan	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Savannah District	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314
4. HOLE NO. (As shown on drawing title and file number) A-5	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED 12, UNDISTURBED 0
5. NAME OF DRILLER T. W. Scott	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED 19 May 79, COMPLETED 19 May 79
7. THICKNESS OF OVERBURDEN 51.0'	17. ELEVATION TOP OF HOLE 27.9'
8. DEPTH DRILLED INTO ROCK 0.0'	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 51.0'	19. SIGNATURE OF INSPECTOR ROBERT V. O'KELLEY, Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		ML-Light grayish brown, fine to medium sandy, clayey silt with rock fragments and gravel		1	NOTE: 4" square auger used from 0.0' to 12.0'. 4" spiral auger used from 12.0' to 51.0'
			Reddish brown		2	
	5					
			SM-Mottled gray to brownish gray, clayey, fine to medium sand with rock fragments		3 4	
	10				5	NOTE: Scale change at 10'.
	12		Green mottled with gray silty, slightly clayey, fine, some mica and minor wood		6	
	14		ML-Light green mottled with green, fine sand, ML is fine sandy, clayey silt with mica, minor wood fragments and trace of calcarious material		7	
	16				8	W. T. 19.1' Date 19 May 79 Depth to water during drilling.
	18		SM-Gray, clayey sand with some mica and wood material Sand fine grained		9	W. T. 19.1' Water table reading 22 hrs. after hole completed.
	20		Fine to coarse, silty vice clayey with minor inclusions of clayey, fine sand			
	22		Green, slightly clayey, fine grained, some mica			
	24					
	26		Continued on sheet 2			

NOTE: Soils field classified in accordance with the Unified Soil Classification System.

PRELIMINARY
SUBJECT TO CORRECTION

DRILLING LOG (Cont Sheet)	[ELEVA]TION TOP OF HOLE 27.9'	Hole No. A-5
PROJECT Cooling Water Facilities Jefferies Steam Plant	INSTALLATION Moncks Corner, SC	SHEET 1 OF 2 SHEETS

ELEVATION a	DEPTH 26 b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	28		ML-Light green, slightly fine sandy, slightly clayey silt with some mica and trace of calcareous material		11	
	30		MH-Light green, very slightly fine sandy, clayey (stiff) with minor mica and trace of calcareous material			NOTE: Scale change at 30'.
	35					
	40					
	45					
			SM-Very light green silty, fine sand with some sand slightly cemented			
	50		Bottom of Boring 51.0'			

PRELIMINARY
SUBJECT TO CORRECTION

Hole No. CS-1

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Moncks Corner, SC	SHEET 1 OF 3 SHEETS

1. PROJECT: Cooling Water Facilities Jefferies Steam Plant
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: Savannah District
4. HOLE NO. (As shown on drawing title and file number): CS-1
5. NAME OF DRILLER: T. W. Scott
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 70.2'
8. DEPTH DRILLED INTO ROCK: 5.0'
9. TOTAL DEPTH OF HOLE: 75.2'
10. SIZE AND TYPE OF BIT: 4" Spiral Auger, 1-3/8" ID Splitspoon, 3" Fishtail, NX casing bit, 2-7/8" Tri-Cone Rock Bit, NX Diamond Core
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: CME-55/Failing 314
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: 1
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 15 May 79; COMPLETED 15 May 79
17. ELEVATION TOP OF HOLE: +25.0 MSL
18. TOTAL CORE RECOVERY FOR BORING: 68 %
19. SIGNATURE OF INSPECTOR: ROBERT V. O'KELLEY, Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	BLOWS
	0		SC-Reddish brown, slightly clayey, fine sand with rock fragments		1	NOTE: Boring cleaned with 2-7/8" rock bit or 4" spiral auger between each split-spoon drive.	14
23.5							14
			Greenish gray mottled with reddish brown, minor rock fragments		2		7
	5				3		11
19.0			Pebble size inclusions of partially lithified calcareous sand (Marl)			NOTE: NX casing set to 30.0'.	9
							11
	10				4	W. T. 10.5' Date 15 May 79	12
13.0							9
			SM-Dark gray, organic silty fine sand		5	Depth to water during drilling.	12
11.5			SC-Gray, clayey, fine to medium sand with minor wood material		6		16
	15					W. T. 3.5' Water table reading 18 hrs. after hole completed.	39
8.5			SM-Gray, calcareous, silty, fine to medium sand with pebble size lithified fragments of calcareous sand		7		29
							23
5.5			Some coarse sand				
4.0	20		ML-Grayish green, inorganic, slightly clayey silt with minor mica and calcareous material		8		[illegible]4
							30
			Slightly fine sandy				[illegible]
0.5	25		Fine sand in "paper thin" lenses				33
							50
-2.0			MH-Grayish green, inorganic clayey, fine sandy silt with minor mica and calcareous material		9		100/0.8
-3.5							40
-5.0	30		ML-Grayish green, inorganic fine sandy, slightly clayey silt with minor mica and calcareous material		10		

Continued on sheet 2

PRELIMINARY SUBJECT TO CORRECTION

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE: +25.0' MSL | **Hole No.** CS-1

PROJECT: Cooling Water Facilities Jefferies Steam Plant | INSTALLATION: Moncks Corner, SC | SHEET 2 OF 3 SHEETS

ELEVATION	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	BLOWS
-5.0	30		ML-Grayish green, inorganic, slightly clayey, fine sandy silt with minor mica and calcareous material				27
-8.0			Minor identifable shell fragments				25
-9.5							30
-11.0	35		SM-Grayish green, silty, fine to medium grained, calcareous sand (Marl)		11		100/0.6
							100/1.0
			Light grayish green due to reduced pergentage of dark green, fine to medium sand size grains (dark grains) now c 10%		12		100/0.8
	40						90
							100/1.0
							100/0.7
	45						87
-21.0			Greenish gray due to increase in dark calcareous grains to 30-40%				100/1.0
							100/1.0
							100/1.0
	50					NOTE: Began splitspooning on 5.0' centers at 48.0'.	
	55						90
						NOTE: Over cleaned boring by 2.0' between 63.0' and 65.0'.	
	60						100/1.0
	65						85
-45.0	70						

Continued on sheet 3

PRELIMINARY
SUBJECT TO CORRECTION

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE +25.0' MSL		Hole No. CS-1
PROJECT Cooling Water Facilities Jefferies Steam Plant	INSTALLATION - Moncks Corner, SC		SHEET 3 OF 3 SHEETS

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
a	b	c	d	e	f	g
-45.0	70				BOX	100.02
-45.2			SM-Grayish green, silty fine to medium grained, calcareous sand (Marl) dark sand grains are 30-40% of total Top of Rock 70.2' Limestone (coquina)-gray, hard to moderately hard, fossiliferous, fractured at numerous points along length with calcareous SM (Marl) present at all fractures. 70.2' - 70.5' badly fractured 72.0' - 75.2' slightly friable and vuggy	68 RQD 26	1	Pull 1 From 70.2 to 75.2' Run 5.0' Rec 3.4' CL 1.6' NOTE: Majority of core loss probably from 72.0' to 73.6' NOTE: Scale change at 70.0'.
	72					
	74			75.2'		
-50.2			Bottom of Boring 75.2'			

NOTE: Soils field classified in accordance with the Unified Soil Classification System.

BLOWS PER FOOT:
Number required to drive 1-3/8" ID splitspoon w/ 140 lb. hammer falling 30".

PRELIMINARY
SUBJECT TO CORRECTION

Hole No. CS-2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Moncks Corner, SC	SHEET 1 OF 1 SHEETS

1. PROJECT Cooling Water Facilities Jefferies Steam Plant
2. LOCATION (Coordinates or Station) See Plan
3. DRILLING AGENCY Savannah District
4. HOLE NO. (As shown on drawing title and file number) CS-2
5. NAME OF DRILLER T. W. Scott
6. DIRECTION OF HOLE [x] VERTICAL [ ] INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 25.5'
8. DEPTH DRILLED INTO ROCK 0.0'
9. TOTAL DEPTH OF HOLE 25.5'
10. SIZE AND TYPE OF BIT 1-3/8" ID splitspoon, 4" spiral auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 10; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 19 May 79; COMPLETED 19 May 79
17. ELEVATION TOP OF HOLE 17.3'
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR ROBERT V. O'KELLEY, Geologist

ELEVATION a	DEPTH 0 b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	BLOWS
			SM-Brown, silty, very slightly clayey sand with roots		1		10
							7
						W. T. 6.2' Date 19 May 79 Depth to water during drilling.	10
	5		ML-Light brown to light green, mottled, clayey, slightly fine sandy silt		2		
					3		11
			SM-Grayish brown, silty, fine to medium sand with CL between 9.6' and 9.8'				14
							17
	10				4	W. T. 6.2' Water table reading 23 hrs. after hole completed.	48
			Slightly silty, fine to coarse quartz sand				28
			Moderately silty, fine to medium				8
			Grayish green, silty, fine, minor calcarious		5		90
	15				6		19
			ML-Light green, slightly fine sandy, slightly clayey silt with trace of calcareous material		7		30
							16
	20		MH-Light green, clayey tight, slightly fine sandy silt		8		58
			ML-Light green, slightly clayey, fine to medium sandy silt		9		32
			SM-Gray, silty, fine to coarse sand with minor gravel		10		32
	25		ML-Light green, slightly fine sandy silt with a trace of calcareous material				48

Bottom of Boring 25.5'

NOTE: Soils field classified in accordance with the Unified Soil Classification System.

PRELIMINARY SUBJECT TO CORRECTION

BLOWS PER FOOT: Number required to drive 1-3/8" ID splitspoon w/140 lb. hammer falling 30".

EXHIBIT H

Hole No. CS-3

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Moncks Corner, SC	SHEET 1 OF 1 SHEETS

1. PROJECT: Cooling Water Facilities Jefferies Steam Plant
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: Savannah District
4. HOLE NO. (As shown on drawing title and file number): CS-3
5. NAME OF DRILLER: T. W. Scott
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 25.5'
8. DEPTH DRILLED INTO ROCK: 0.0'
9. TOTAL DEPTH OF HOLE: 25.5'
10. SIZE AND TYPE OF BIT: 4" spiral auger, 1-3/8" ID splitspoon
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 314
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 7; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 19 May 79; COMPLETED 19 May 79
17. ELEVATION TOP OF HOLE: 17.1'
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: ROBERT V. O'KELLEY, Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	BLOWS
	0		SM-Reddish brown, silty, fine to medium sand with some roots		1		17
							24
			Less consolidated			W. T. 8.4' Date 19 May 79 Depth to water during drilling.	8
	5		Gray to dark gray, clayey, wood fragments		2		6
							14
			Gray mottled with green			W. T. 8.4' Water table reading 19 hrs. after hole completed.	18
	10		Light gray, silty, fine to medium quartz sand		3		33
							27
			Fine to coarse				22
			Slightly silty to silty				22
	15		Light greenish brown, fine to medium moderate mica content		4		20
			Light gray, fine to coarse, some gravel		5		20
					6		11
	20						18
							20
							17
	25		ML-Light green, slightly fine sandy, slightly clayey silt with minor mica and trace of calcareous material		7		44
			Bottom of Boring 25.5'				

NOTE: Soils field classified in accordance with the Unified Soil Classification System.

BLOWS PER FOOT:
Number required to drive 1-3/8" ID splitspoon w/140 lb. hammer falling 30"

PRELIMINARY SUBJECT TO CORRECTION

EXIHIBIT H

Hole No. CS-4

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Moncks Corner, SC	SHEET 1 OF 3 SHEETS

1. PROJECT: Cooling Water Facilities Jefferies Steam Plant	10. SIZE AND TYPE OF BIT: 4" Spiral Auger, 1-3/8" ID Splitspoon 7" Fishtail, 6" rock bit 4x5½" Diamond Core
2. LOCATION (Coordinates or Station): See Plan	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Savannah District	12. MANUFACTURER'S DESIGNATION OF DRILL: Falling 314
4. HOLE NO. (As shown on drawing title and file number): CS-4	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 17; UNDISTURBED 0
5. NAME OF DRILLER: T. W. Scott	14. TOTAL NUMBER CORE BOXES: 2
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 21 May 79; COMPLETED 23 May 79
	17. ELEVATION TOP OF HOLE: +26.2' MSL
7. THICKNESS OF OVERBURDEN: 74.0'	18. TOTAL CORE RECOVERY FOR BORING: 84 %
8. DEPTH DRILLED INTO ROCK: 6.5'	19. SIGNATURE OF INSPECTOR: ROBERT V. O'Kelley, Geologist
9. TOTAL DEPTH OF HOLE: 80.5'	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	BLOWS
			ML-Mottled brown to light green, slightly clayey, fine sandy silt with some rock fragments, mica and a trace of organic material		1	NOTE: Shovel used to remove sample from 0.0' to 1.5'.	6, 2
21.7	5		CL-Mottled light brown, green and gray, slightly silty to sandy clay		2	W. T. 12.0' Date 21 May 79 Depth to water during drilling.	2, 3
18.7			Root fragments				3
17.2	10		Slight increase in medium sand fraction		3	W. T. 9.1' Water table reading 22 hrs. after hole completed.	5, 6, 10
	15		13.4' to 13.5' thin lense of ML-Light green, very slightly fine sandy silt with some mica and a trace of calcareous material		4		9, 12
8.7			Gray		5	NOTE: Split-spoon drives from 0.0' to 9.0' taken in loosely consolidated fill material.	11, 16
5.9	20		SM-Gray, silty, fine to medium grained, quartz sand with minor coarse sand		6		30
3.7			Green, fine, trace of calcareous material				40
2.2			Compacted				26
0.7	25		Some sand loosely cemented				52, 90
-2.3			MH-Light green, slightly fine sandy, clayey, tight silt		9		55, 25
-3.8	30		Continued on sheet 2				

NOTE: Soils field classified in accordance with the Unified Soil Classification System.

BLOWS PER FOOT: Number required to drive 1-3/8" ID splitspoon w/ 140 lb. hammer falling 30".

PRELIMINARY SUBJECT TO CORRECTION

EXHIBIT H

DRILLING LOG (Cont Sheet) E[illegible]ON TOP OF HOLE

Hole No. CS-4

PROJECT Cooling Water Facilities Jefferies Steam Plant | INSTALLATION Moncks Corner, SC | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	BLOWS
	30		ML-Light green, fine sandy (paper thin lenses), very slightly clayey silt with a trace of calcareous material		JAR 10	NOTE: Material from 43.2' to 74.0' is a loosely consolidated marl herein classified as an ML or SM and included as a portion of the overburden in item #7 of this log.	50 40 55 38 63 40
-8.3	35		Slight increase in content of calcareous material				
-14,3	40						39
-15,8			20% dark, fine sand				48
-17,0			Dark fine sand now 50%		11	Fishtail Refusal at 43.3'	100/0.7 100/0.1
	45		ML-Green, fine to medium sandy silt with limestone fragments	64 RQD 0.0 48.3	12 BOX 1	Pull 1 From 43.3' to 48.3' Run 5.0' Rec 3.2' CL 1.8'	
-22.1			SM-Light green, silty calcareous, fine sand		JAR 13	Splitspoon	100/0.6
	50			100 RQD 0.0 54.4	BOX 1 BOX 2	Pull 2 From 49.4' to 54.4' Run 5.0' Rec 5.0' CL 0.0'	
-28.2	55		Green with 30% dark, fine grained sand		JAR 14	NOTE: Began splitspooning on 5.0' centers at 54.4' 6" rock bit used to clean boring between drives.	100/0.9
	60				15		100/0.4
-38.2	65		Minor shell fragments				100/0.9
-43.2							
-43.8	70		50% dark, fine sand		17		

Continued on sheet 3

PRELIMINARY SUBJECT TO CORRECTION

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE +26.2' MSL	Hole No. CS-4
PROJECT Cooling Water Facilities Jefferies Steam Plant	INSTALLATION Moncks Corner, SC	SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	BLOWS
	70		SM-Green to dark green, silty, calcareous fine sand Top of Firm Rock 74.0'		JAR	NOTE: Scale change at 75.0' Rock Bit Refusal at 74.0'.	26 100/0.1
-47.8	75 77 79		Limestone (coquina)-Gray, hard, fossiliferous, vuggy 74.0' to 76.1' vugs filled with indurated, silty, fine to medium sand (Marl), slightly glauconitic 76.1' to 80.5' vugs filled with very slightly indurated, silty, fine to medium sand (Marl) 74.5', 75.2', 75.3', 76.2', 76.5', 76.6', 76.7', 77.1' and 77.9' natural breaks with light green, very slightly indurated, silty, fine to medium sand (Marl) evident at all breaks	67 RQD 0.0 94 RQD 62 80.5	BOX 2	Pull 3 From 74.0' to 75.5' Run 1.5' Rec 1.0' CL 0.5' Pull 4 From 75.5' to 80.5' Run 5.0' Rec 4.7' CL 0.3'	
-54.3			Bottom of Boring 80.5'				

PRELIMINARY
SUBJECT TO CORRECTION

Hole No. CS-5

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Moncks Corner, SC	SHEET 1 OF 3 SHEETS

1. PROJECT: Cooling Water Facilities Jefferies Steam Plant	10. SIZE AND TYPE OF BIT: 7" Fishtail, 1-3/8" ID Splitspoon, 4x5½" Diamond Core
2. LOCATION (Coordinates or Station): See Plan	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Savannah District	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 314
4. HOLE NO. (As shown on drawing title and file number): CS-5	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 15; UNDISTURBED 0
5. NAME OF DRILLER: T. W. Scott	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER:
	16. DATE HOLE: STARTED 23 May 79; COMPLETED 24 May 79
7. THICKNESS OF OVERBURDEN: 80.0'	17. ELEVATION TOP OF HOLE: +29.0'
8. DEPTH DRILLED INTO ROCK: 6.0'	18. TOTAL CORE RECOVERY FOR BORING: 90 %
9. TOTAL DEPTH OF HOLE: 86.0'	19. SIGNATURE OF INSPECTOR: ROBERT V. O'KELLEY, Geologist

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) f BLOWS
			ML-Mottled brown, reddish brown and light green, clayey fine to medium, sandy, silt with rock fragments, organic material and mica		1	20
						5
					2	4
	5					4
21.5						4
20.0			Increased compaction			9
	10		SM-Mottled grayish green, reddish brown and gray, silty, clayey, fine to medium sand		3	6
						13
15.5						14
	15		Green, silty fine to medium sand and minor gray, very slightly clayey, silty fine to medium sand		4	8
						10
						14
9.5						10
	20		Moderate amount of gray, fine to medium sand now present		5	12
7.0			Gray, silty, fine to medium, water bearing, quartz sand with 20% coarse sand		6	34
						90
3.5	25		Fine to coarse with 10 to 20% "Pea size" gravel		7	100/0.8
2.0			Green to dark green, fine to medium and silty with minor mica and a trace of calcareous material		8	60
0.5						37
-1.0						100/0.9
	30		Moderately silty, compacted and partially indurated		9	

Continued on sheet 2

PRELIMINARY SUBJECT TO CORRECTION

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE +29.0' MSL **Hole No.** CS-5

PROJECT Cooling Water Facilities Jefferies Steam Plant | INSTALLATION Moncks Corner, SC | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	BLOWS
- 1.0	30		SM-Green to dark green, slightly to moderately silty, fine to medium sand with minor mica and a trace of calcareous material				100/0.9
- 3.5							49
							42
	35		Moderately silty to silty		10		
- 7.0							44
							70
			ML-Light green, slightly clayey to clayey, slightly fine sandy silt with minor mica and a trace of calcareous material				47
	40						42
-13.0			MH-Light green, clayey (stiff), very slightly fine sandy, silt with minor mica and a trace of calcareous material		11	NOTE: Began split-spooning on 5.0' centers at 48.0'.	60
							52
	45		Minor fine sandy gray, clayey inclusions				60
						NOTE: Material from 53.0 to 80.0' is a loosely consolidated silty fine to medium calcareous marl herein classified as an SM and is included as part of the overburden in item #7 of this log.	75
-18.4			Slightly clayey to clayey		12		100/0.8
-19.0			ML-Green to dark green, very slightly clayey silt with 20-30% dark fine sand and some calcareous material		13		100/0.2
	50						
-24.0			SM-Green to dark green, silty, very slightly clayey, fine to medium sand with Limestone fragments				100/0.5
	55						
			Light grayish green with shell fragments (Marl)				100/0.6
	60						
							100/0.7
	65						
-39.0			Grayish green				100/0.5
-41.0	70		Continued on sheet 3				

PRELIMINARY
SUBJECT TO CORRECTION

EXHIBIT H

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE: +29.0' MSL | **Hole No.** CS-5

PROJECT: Cooling Water Facilities Jefferies Steam Plant | INSTALLATION: Moncks Corner, SC | SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	BLOWS
	70		SM-Grayish green, silty fine to medium sand with minor shell fragments				
							100/0.5
	75					NOTE: Scale change at 80.0'.	
-49.0			Some tan, silty, fine to med. sand inclusions				
-51.0	80		Top of Firm Rock 80.0'		15	Fishtail Refusal 80.0'	100/0.9
			Limestone (coquina)-Gray, fossiliferous, slightly vuggy, hard 80.0' to 80.6' vugs filled with indurated silty, fine to medium sand (Marl), slightly Glauconitic 80.6' to 86.0' vugs filled with very slightly indurated silty fine to medium sand (Marl) 80.6', 81.1', 82.2', 83.3', 83.4', 83.5', 84.7', 85.3' natural breaks with light green, silty, fine to medium, slightly indurated sand (Marl) evident at all breaks.	90 RQD 78 85.7'	BOX 1	Pull 1 From 80.0' to 86.0' Run 6.0' Rec 5.4' CL 0.6' NOTE: Most core loss is likely to have occurred at 84.7'. NOTE: Difference in tape depth and drilling depth due to fall-in.	
	82						
	84						
-57.0	86		Bottom of Boring 86.0'				

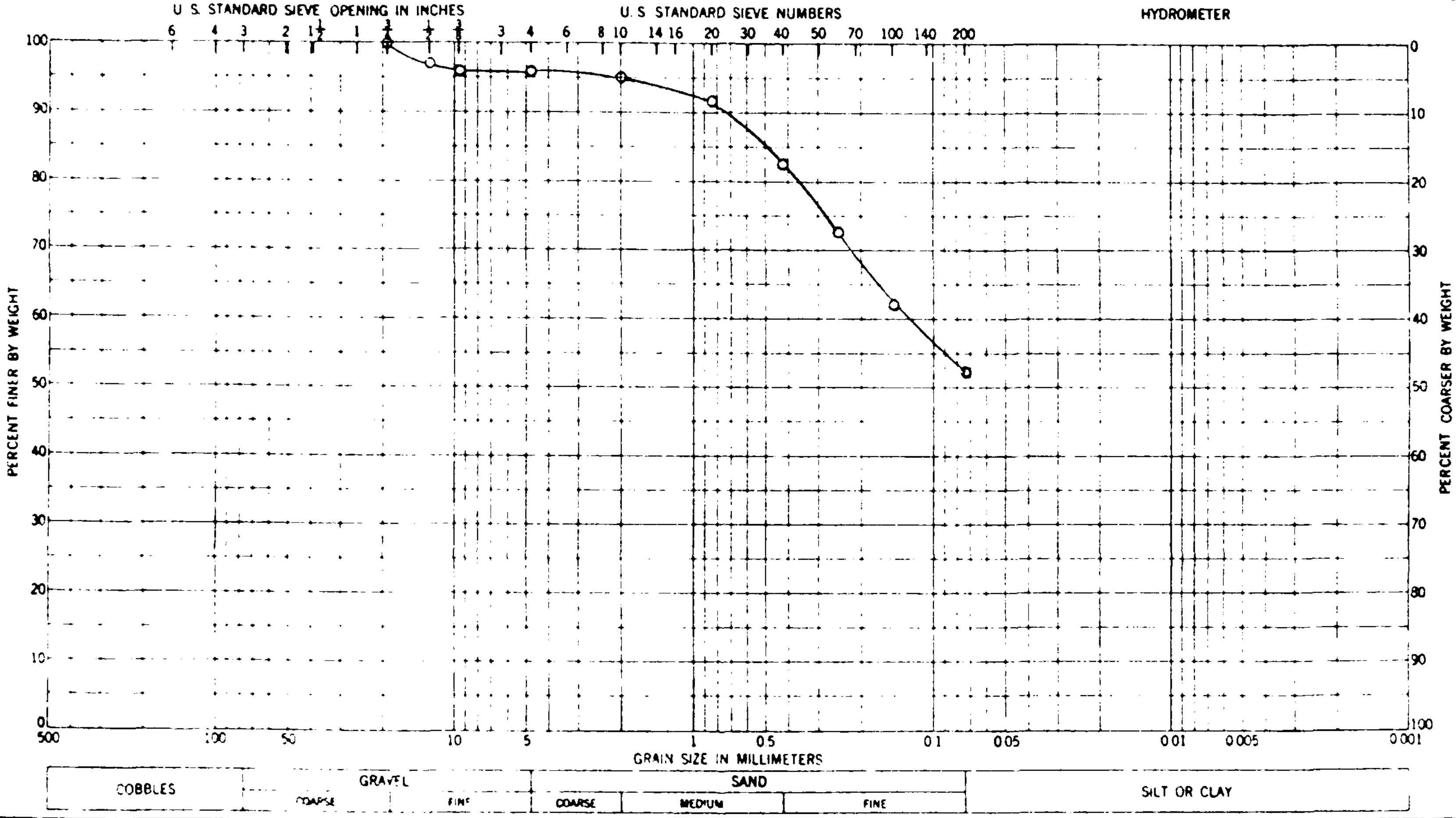
NOTE: Soils field classified in accordance with the Unified Soil Classification System.

PRELIMINARY
SUBJECT TO CORRECTION

BLOWS PER FOOT: Number required to drive 1-3/8" ID Splitspoon w/140 lb. hammer falling 30".

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	1.5'-3.0'	Gray sandy fat clay (CH) with a trace of gravel	27.8	53	23	30

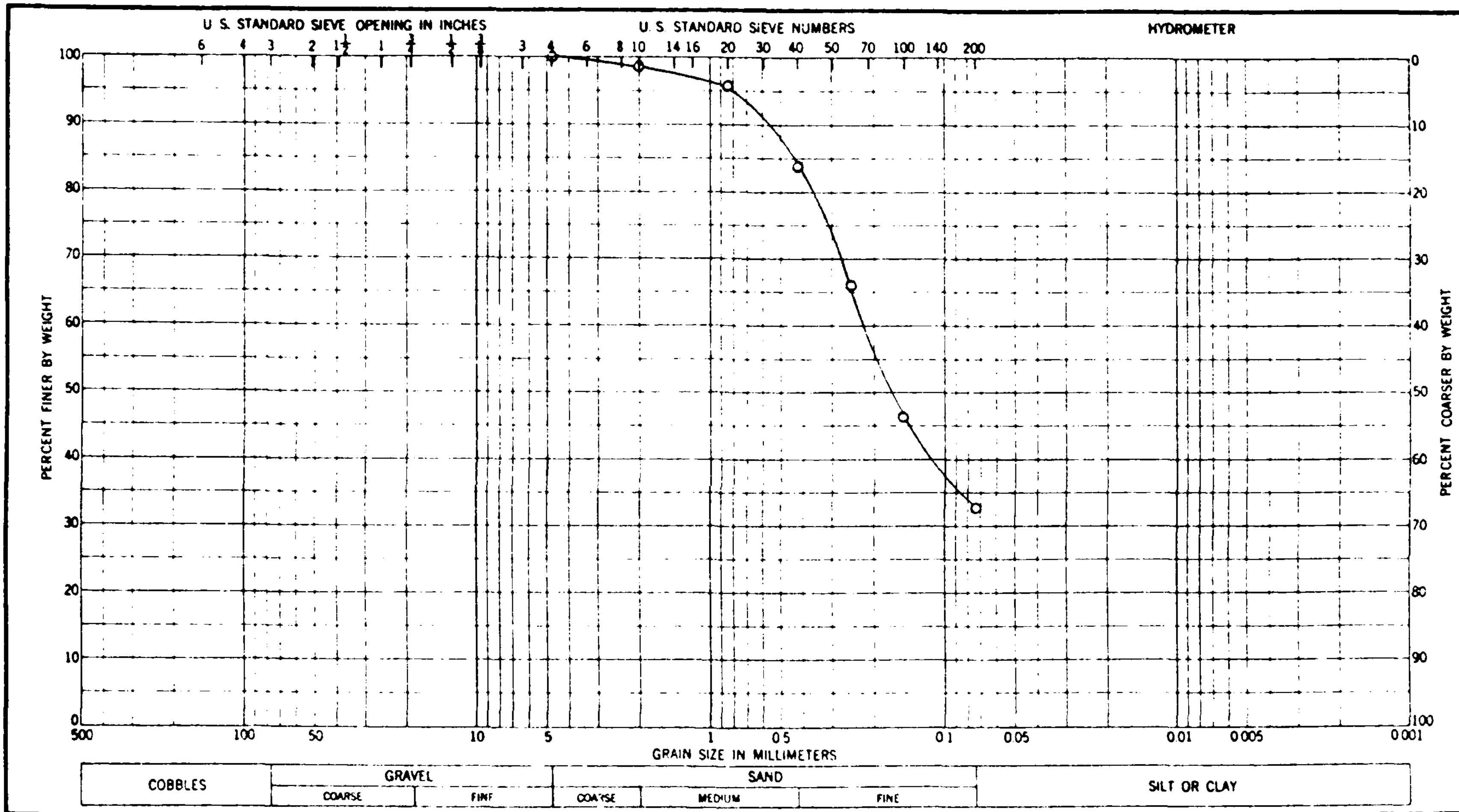
Project Jefferies Steam Plant
Moncks Corner, S.C.
Lab. No. 52/4024
Area Cooling Water Facilities
Boring No CS-1, Sample No. 2
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	12.0-13.5'	Dark gray slightly organic silty sand (SM)	18.6	NP	NP	NP
		Loss on Ignition, 2 hrs. at 600°C = 8.3%				

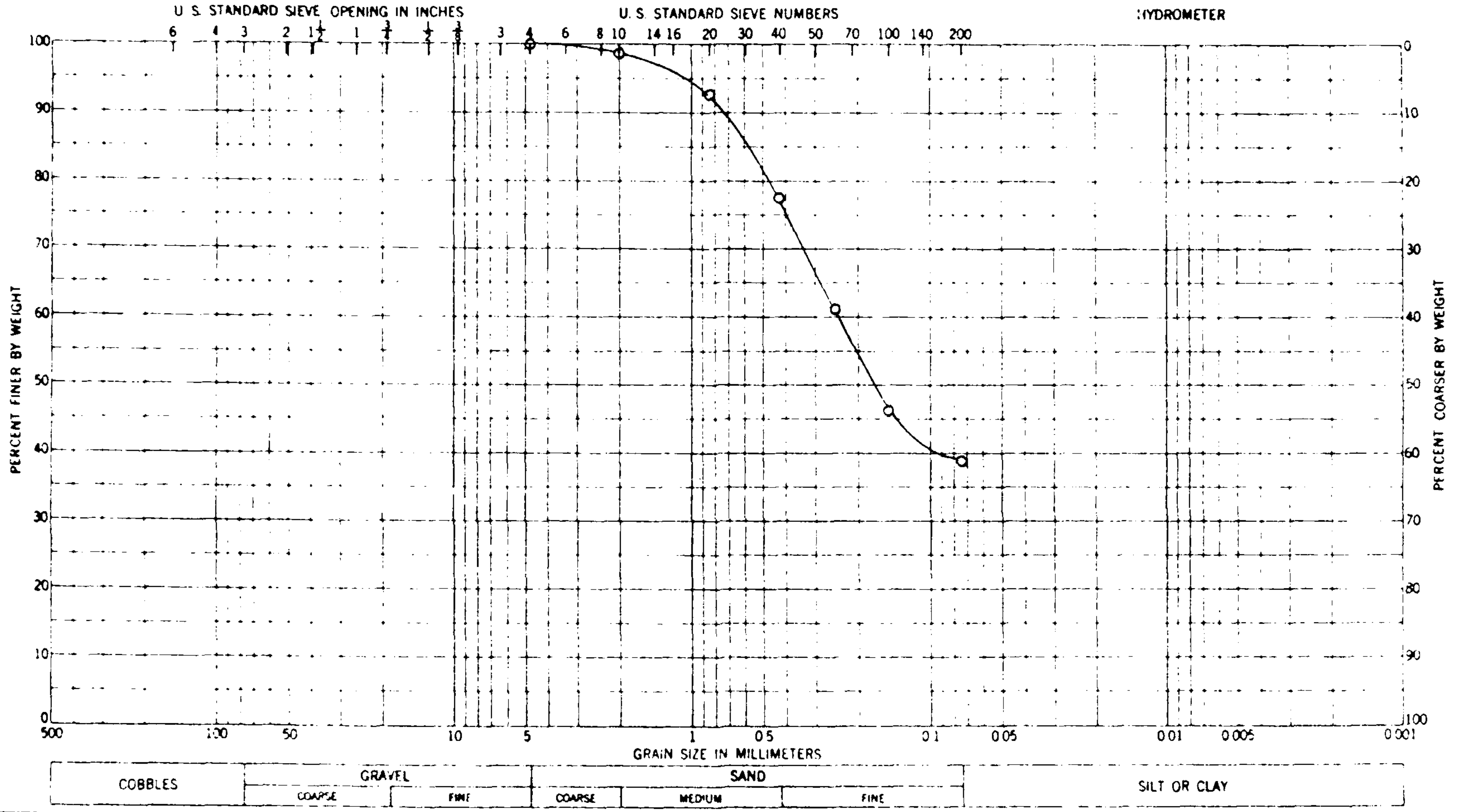
SAVANNAH DIST. Jefferies Steam Plant
Project Moncks Corner, S.C.
Lab. No. 52/4027
Area Cooling Water Facilities
Boring No CS-1, Sample No. 5
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
6	13.5'-15.0'	Gray clayey sand (SC)	17.1	40	15	25

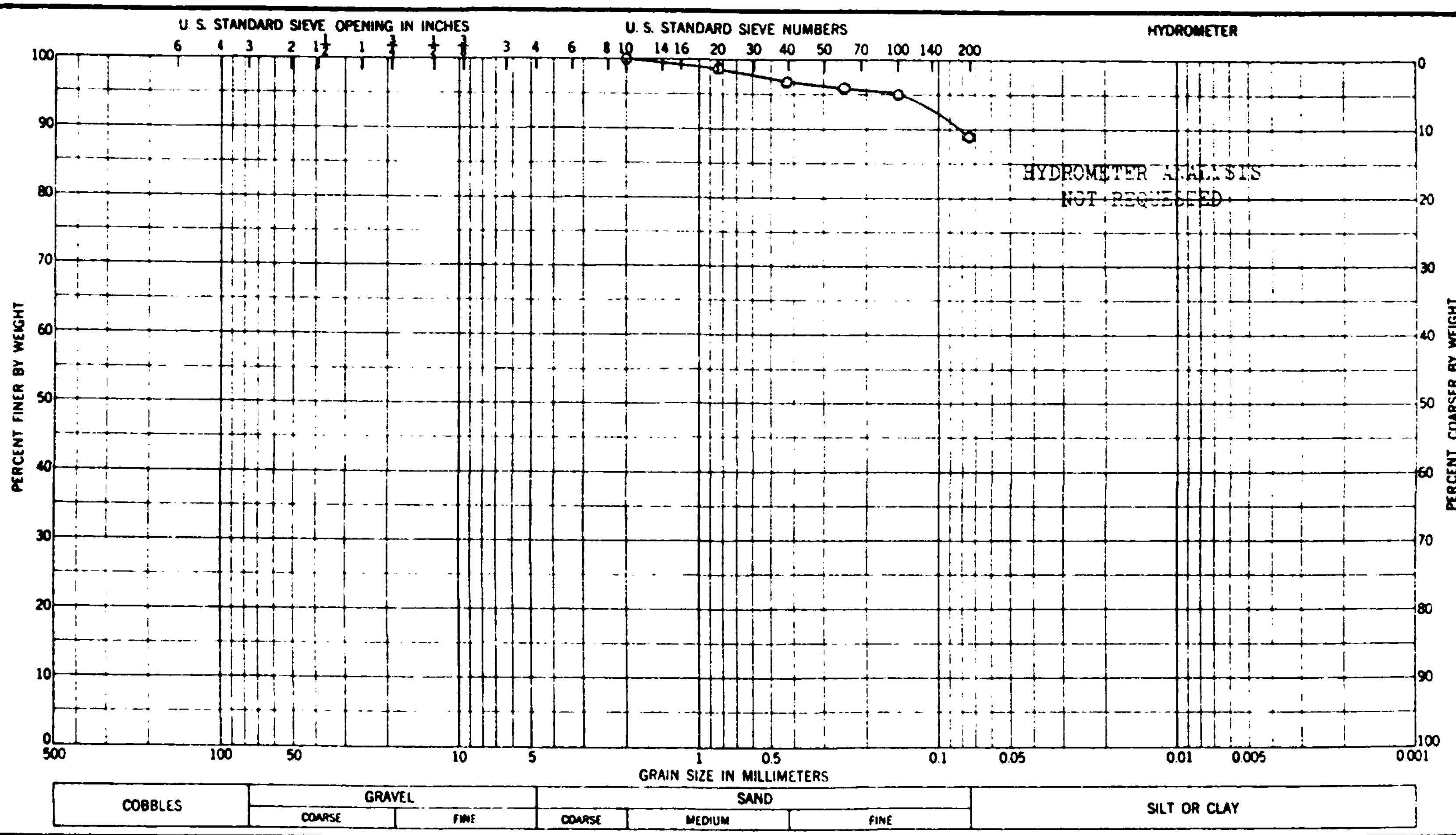
SAVANNAH DIST. Jefferies Steam Plant
Project Moncks Corner, S.C.
Lab. No. 52/4028
Area Cooling Water Facilities
Boring No CS-1, Sample No. 6
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
8	19.5'-21.0'	Gray fat clay (CH) with a little sand	54.0	90	31	59

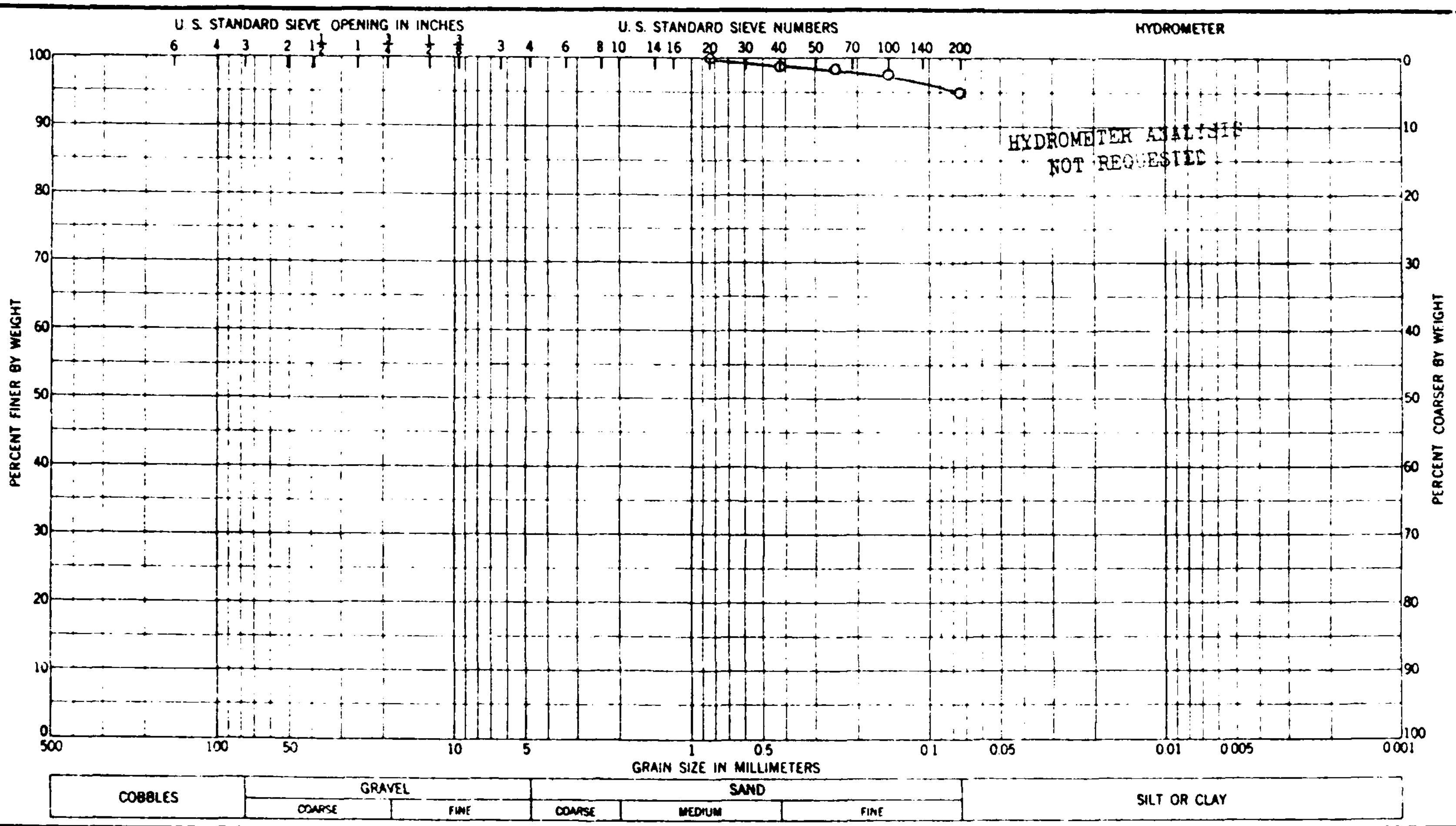
GRADATION CURVES

SAVANNAH DIST. Jefferies Steam Plant
Project Moncks Corner, S.C.
Lab. No. 52/4030
Area Cooling Water Facilities
Boring No. CS-1, Sample No. 8
Date 6 July 1979

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
9	27.0'-28.5'	Gray fat clay (CH) with a trace of sand	42.0	87	31	56

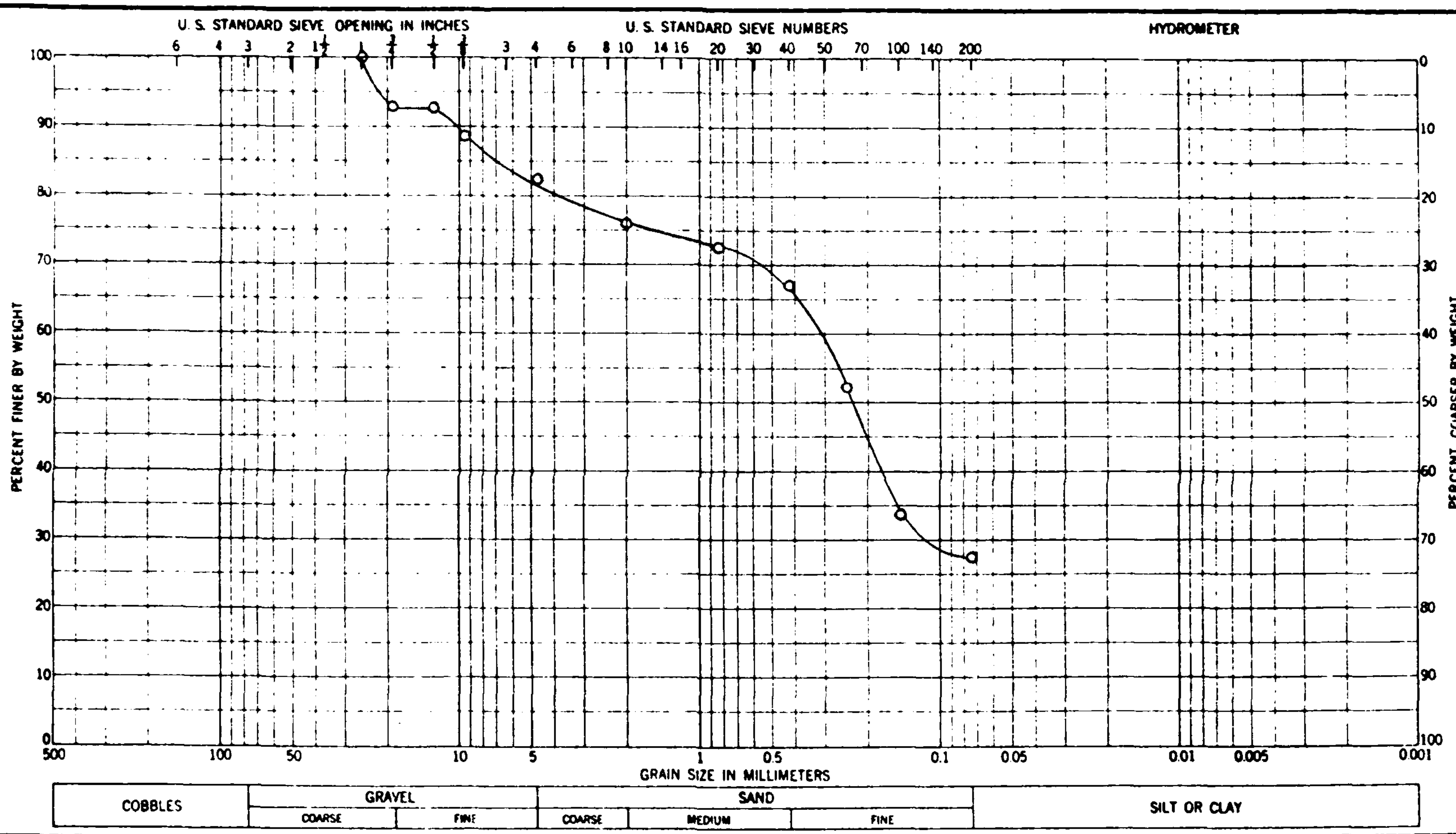
SAVANNAH DIST. Jefferies Steam Plant
Project Moncks Corner, S.C.
Lab. No. 52/4031
Area Cooling Water Facilities
Boring No. CS-1, Sample No. 9
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF TH ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
11	34.5'-36.0	Gray clayey sand (SC) with a little gravel	21.8	35	18	17

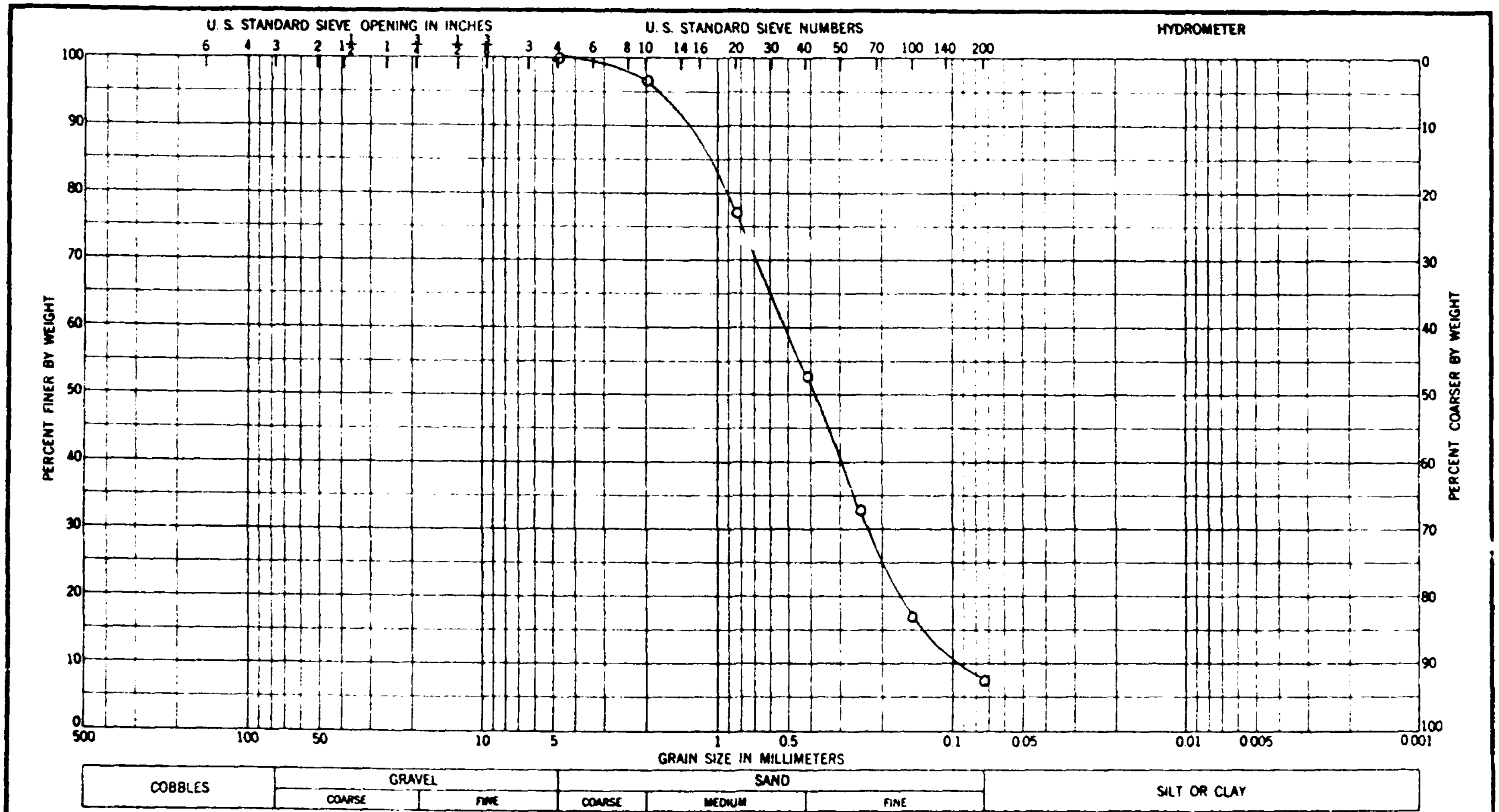
SAVANNAH DIST. Jefferies Steam Plant
Project Moncks Corner, S.C.
Lab. No. 52/4033
Area Cooling Water Facilities
Boring No. CS-1, Sample No. 11
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	9.0'-10.5'	Tan poorly graded silty sand (SP-SM)	15.6	NP	NP	NP

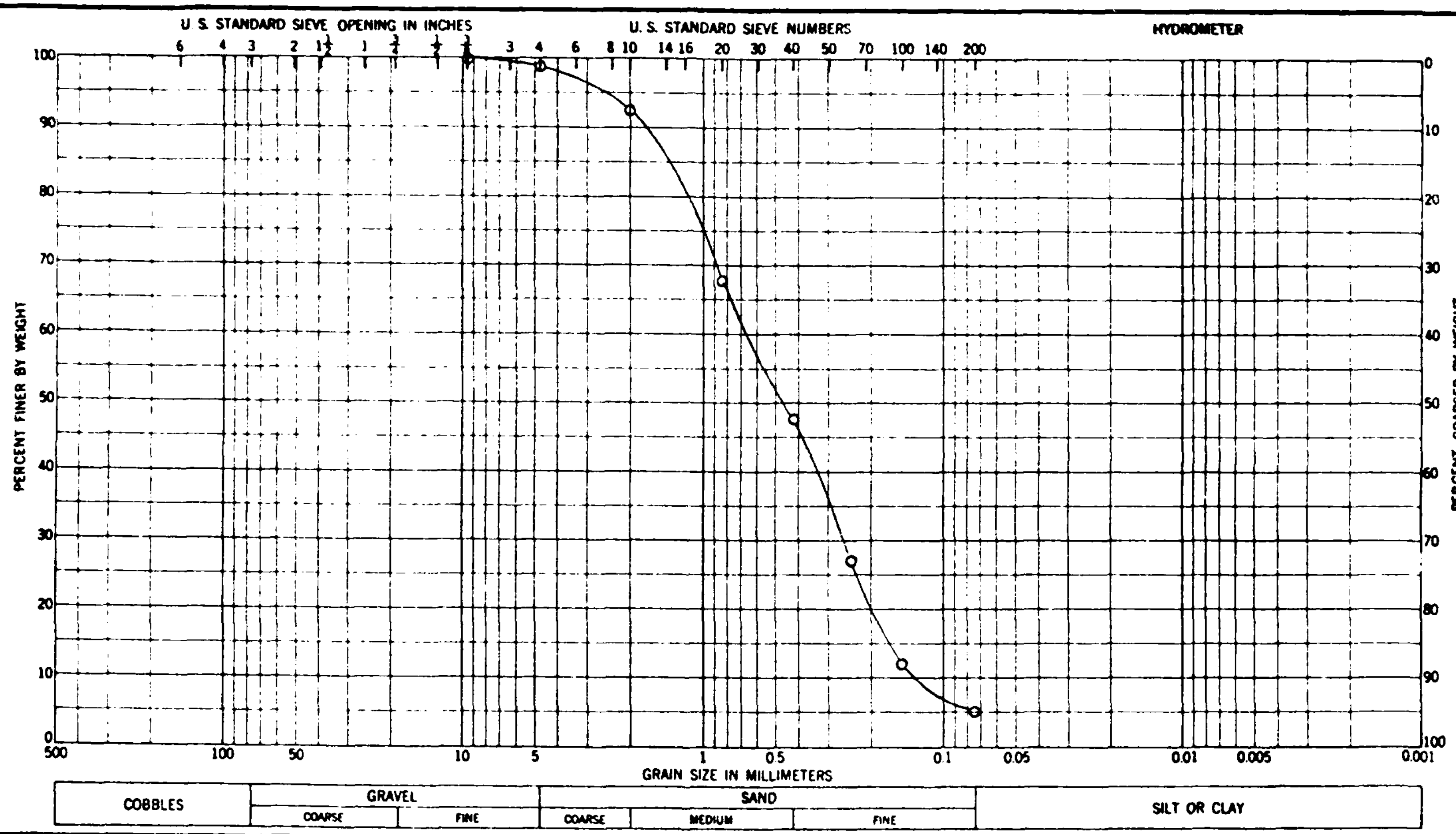
Project SAVANNAH DIST. Jefferies Steam Plant Moncks Corner, S.C.
Lab. No. 52/4038
Area Cooling Water Facilities
Boring No. CS-2, Sample No. 4
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
8	19.5'-21.0'	Gray poorly graded silty sand (SP-SM) with a trace of gravel	16.4	NP	NP	NP

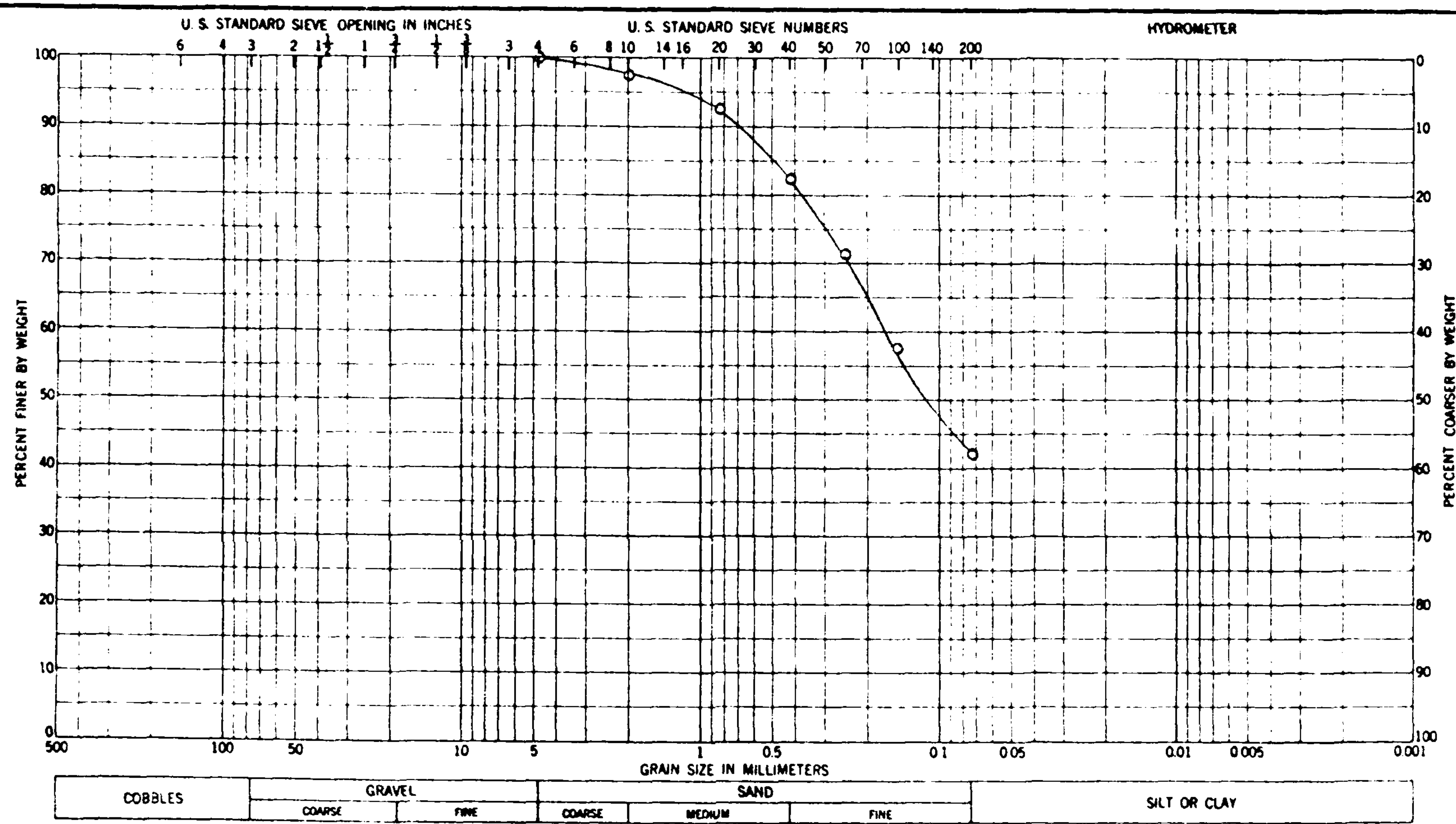
Project: SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4042
Area: Cooling Water Facilities
Boring No. CS-2, Sample No. 8
Date: 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	4.5-6.0'	Black and tan clayey sand high LL (SC-H) with roots	20.6	54	24	30

Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4046

Area Cooling Water Facilities

Boring No. CS-3, Sample No. 2

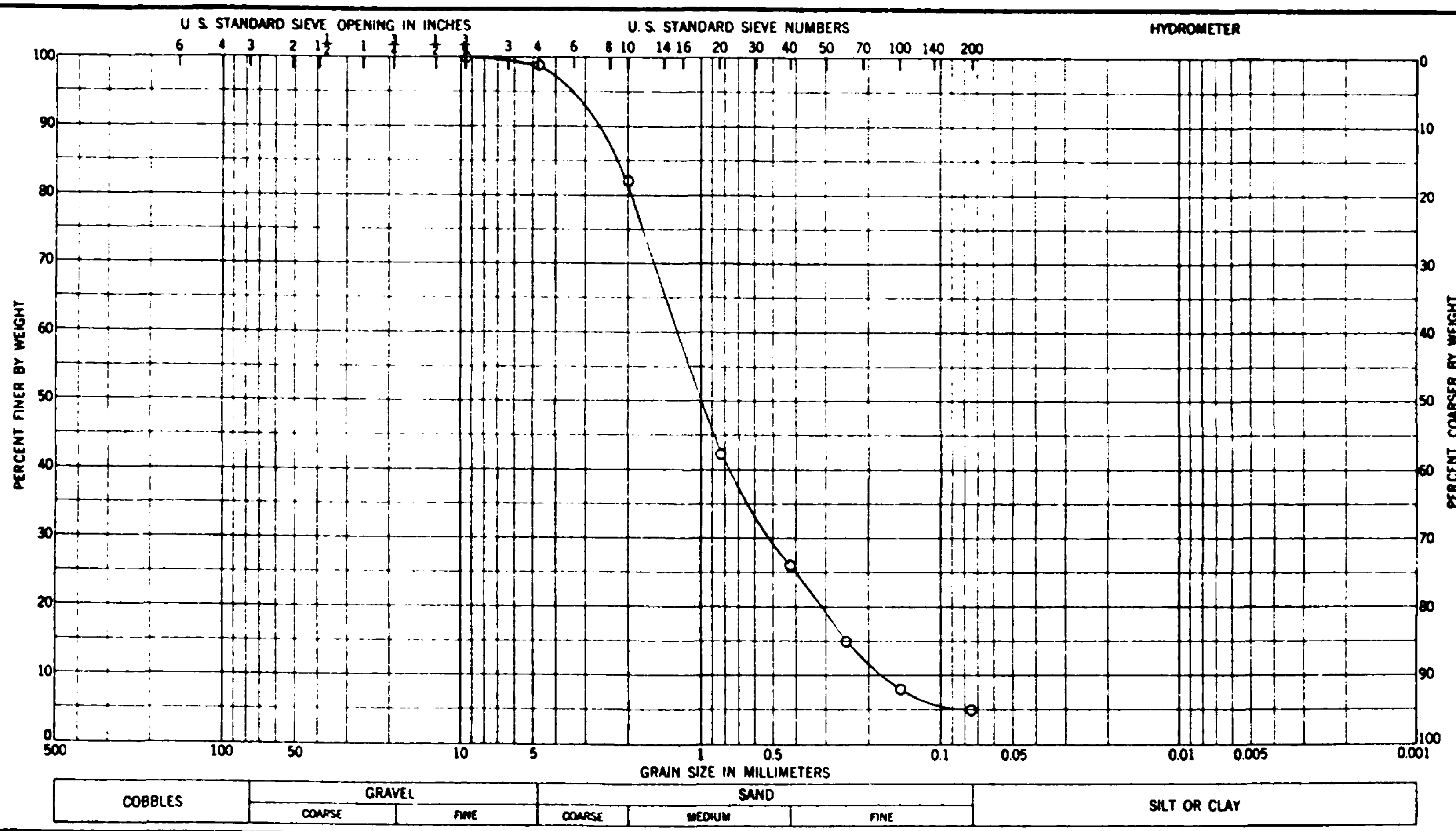
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	15.0'-16.5'	Tan poorly graded silty sand (SP-SM) with a trace of gravel	16.6	NP	NP	NP

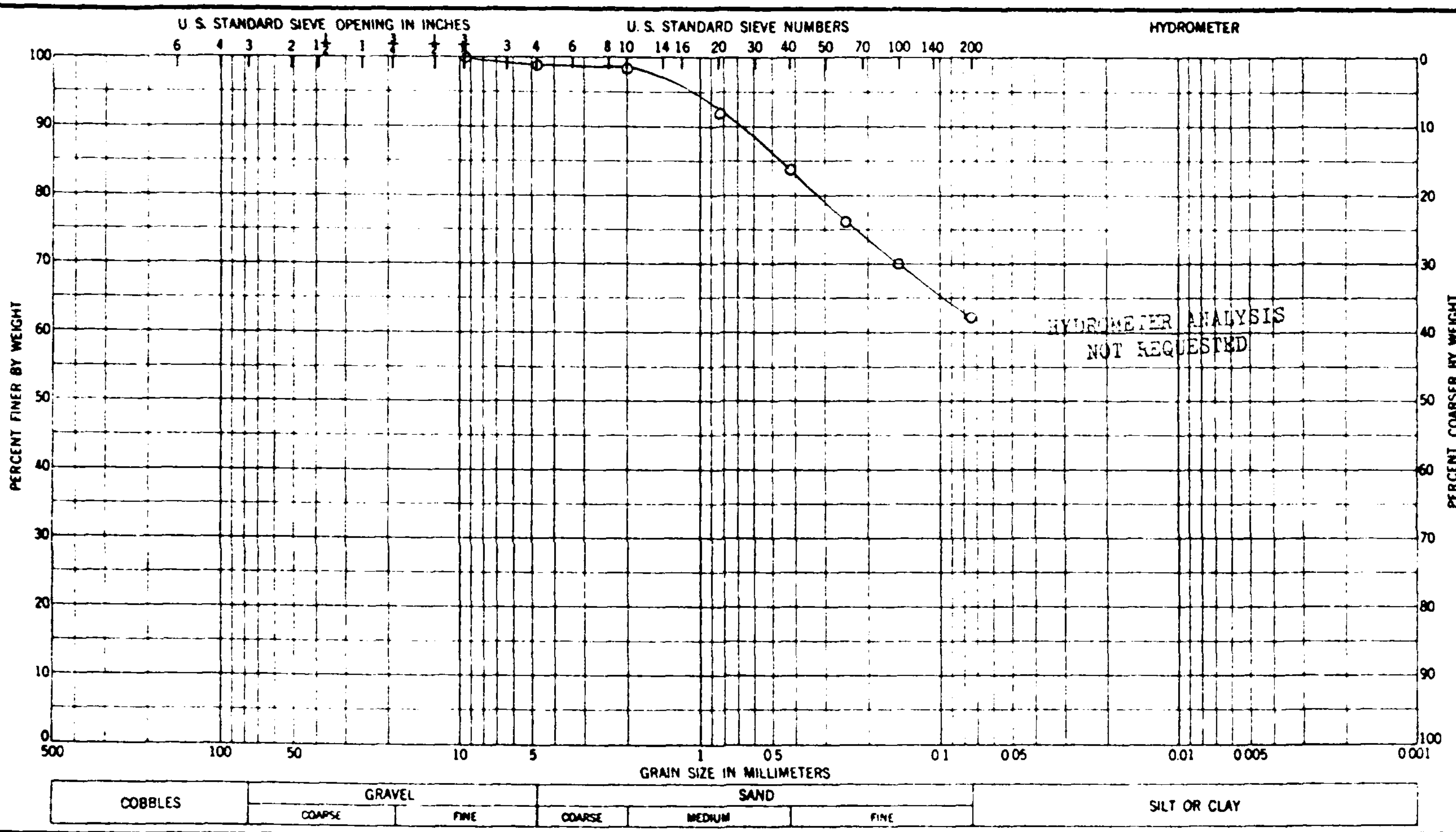
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4049
Area Cooling Water Facilities
Boring No. CS-3, Sample No. 5
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	4.5'-6.0'	Gray sandy fat clay (CH)	40.1	66	25	41

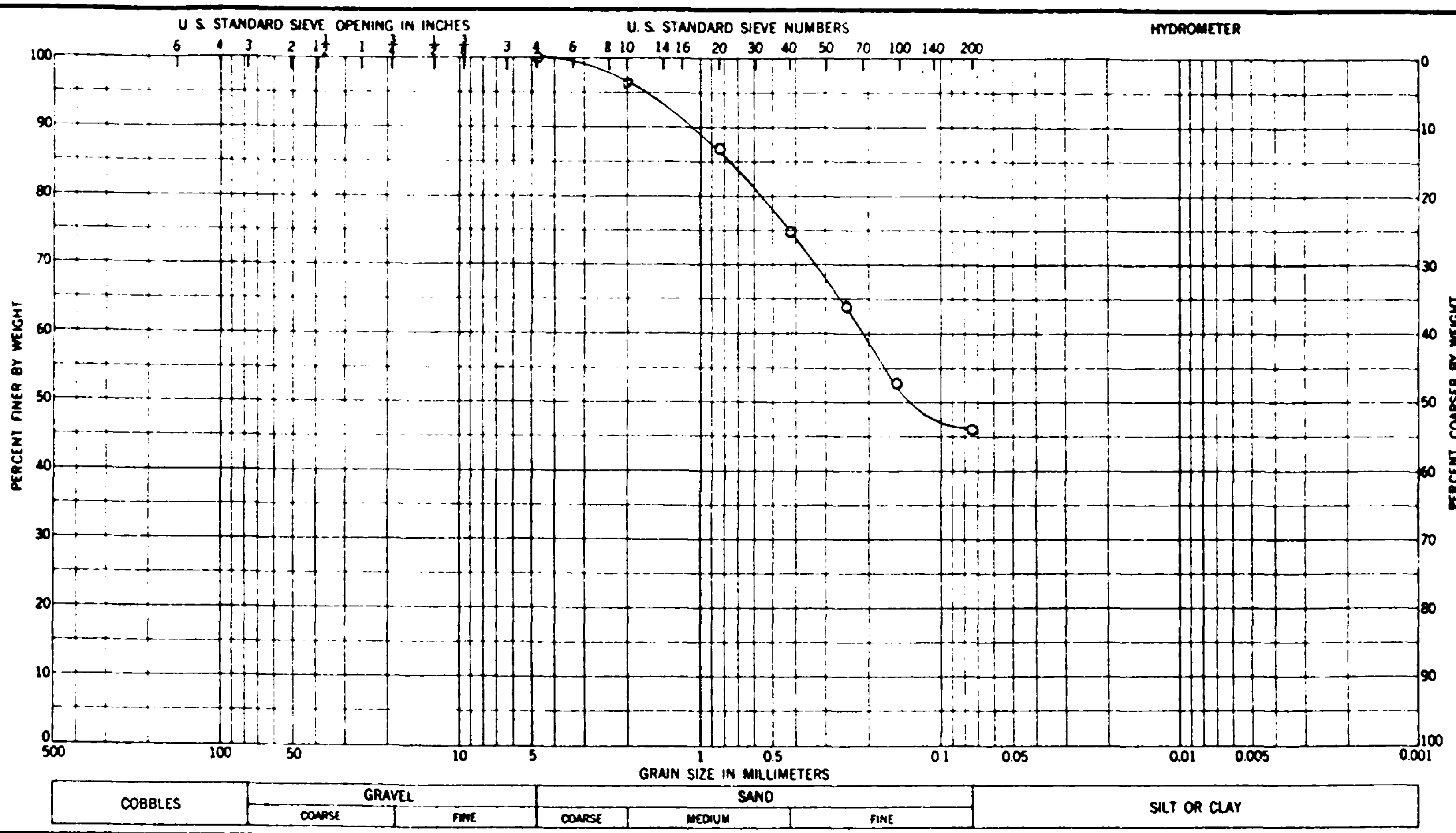
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4053
Area Cooling Water Facilities
Boring No. CS-4, Sample No. 2
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	9.0-10.5'	Gray and black clayey sand high LL (SC-H)	34.1	56	20	36

Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.

Lab. No. 52/4054

Area Cooling Water Facilities

Boring No. CS-4, Sample No. 3

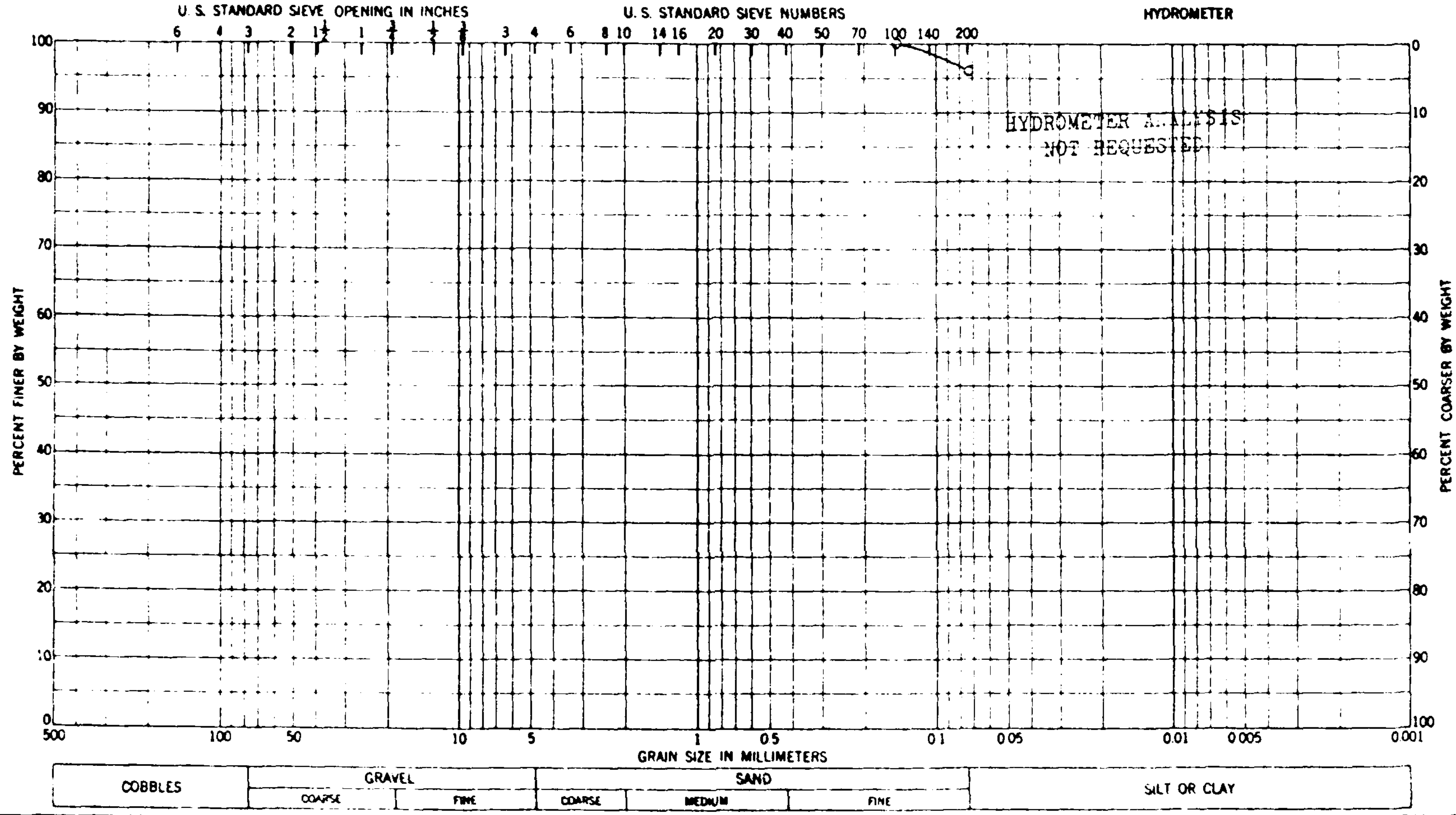
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
9	28.5-30.0'	Gray fat clay (CH) with a trace of sand	39.4	92	31	61

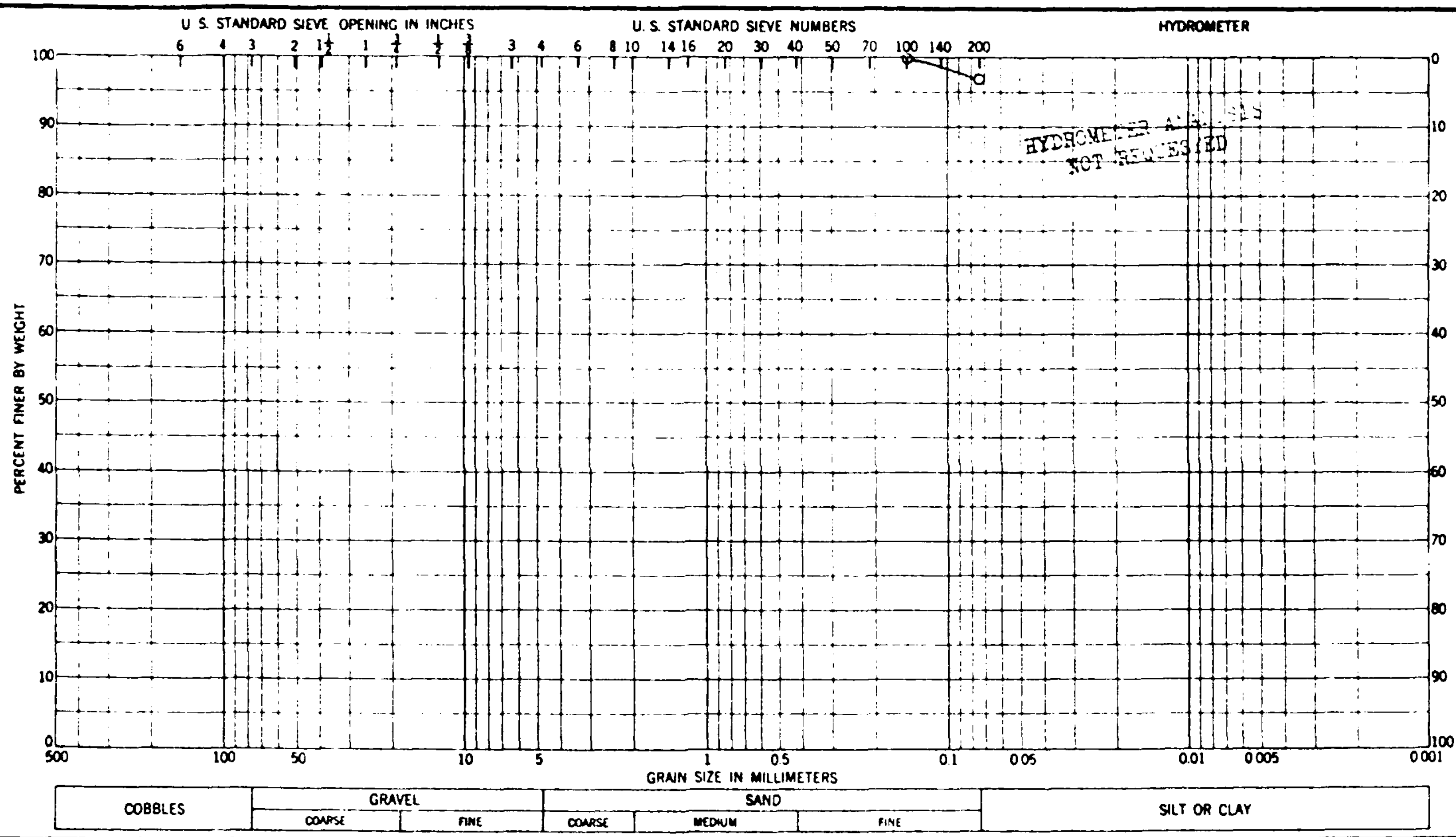
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4060
Area Cooling Water Facilities
Boring No. CS-4, Sample No. 9
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
10	30.0-31.5'	Gray fat clay (CH) with a trace of sand	40.1	87	30	57

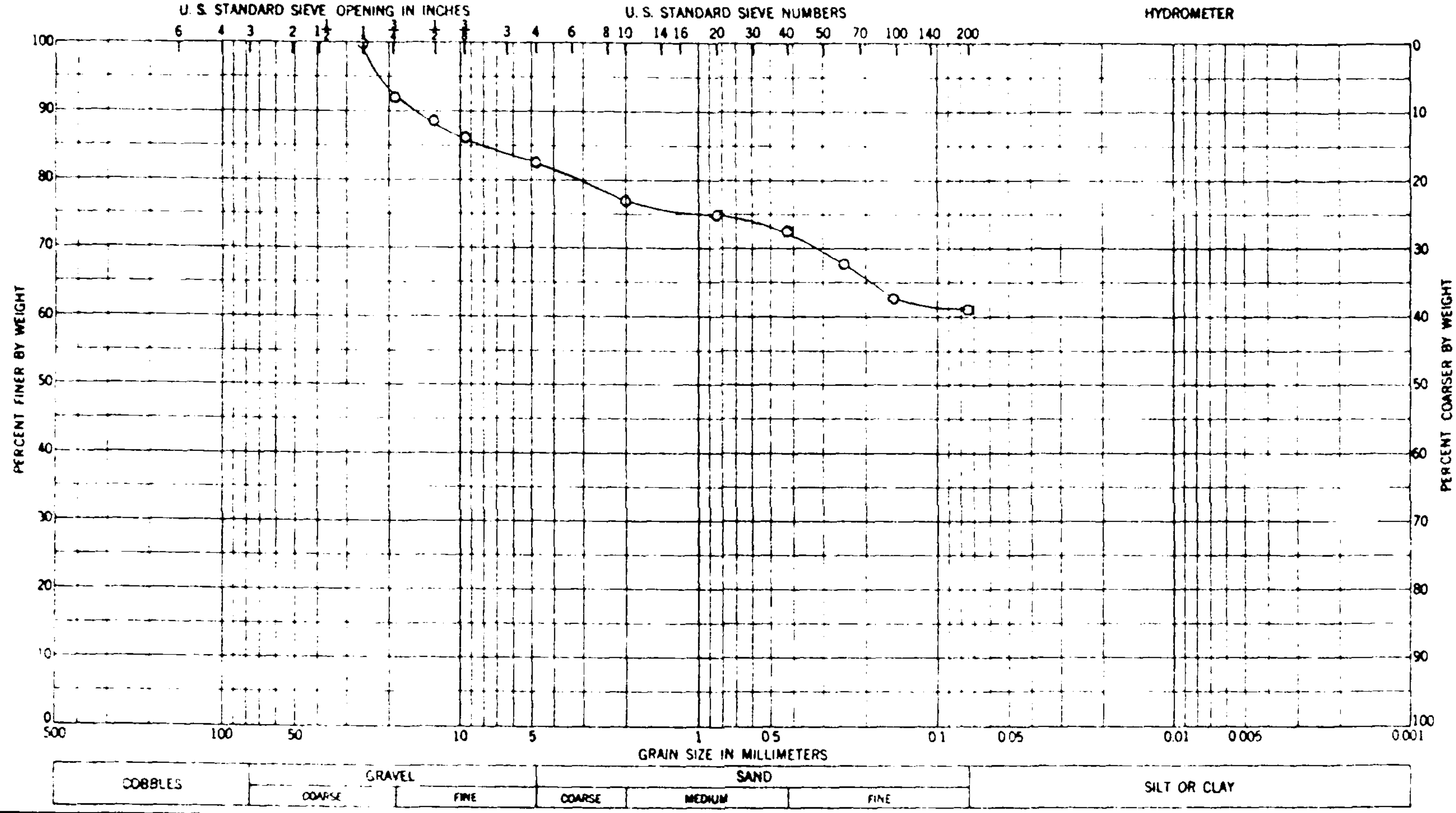
Project: SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4061
Area: Cooling Water Facilities
Boring No. CS-4, Sample No. 10
Date: 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
12	43.2-43.3'	Gray and black sandy lean clay (CL) with a little gravel	17.7	33	17	16

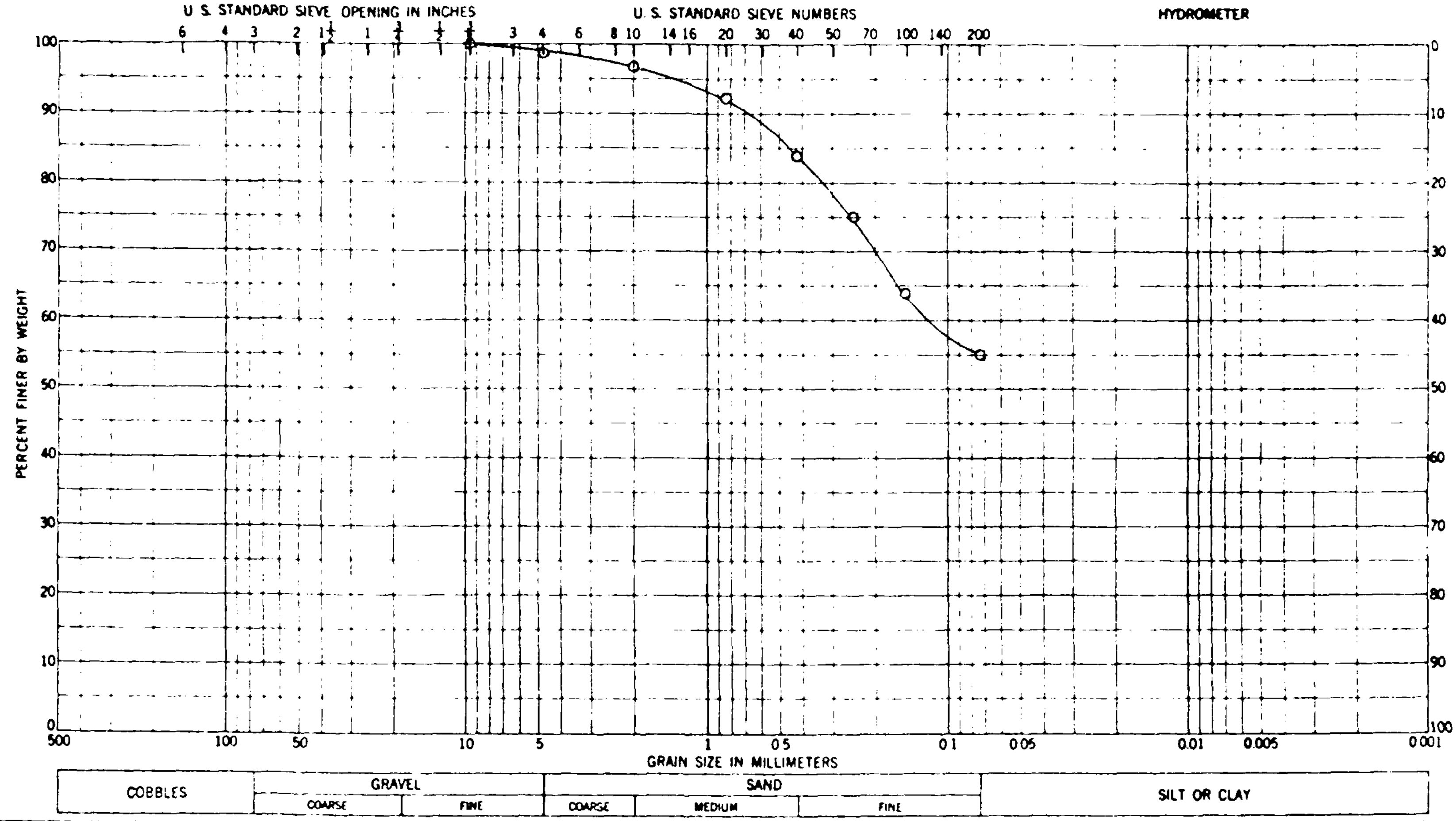
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4063
Area Cooling Water Facilities
Boring No. CS-4, Sample No. 12
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	4.5-6.0'	Gray and red sandy fat clay (CH) with a trace of gravel sized coal	33.1	53	21	32

Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.

Lab. No. 52/4070

Area Cooling Water Facilities

Boring No. CS-5, Sample No. 2

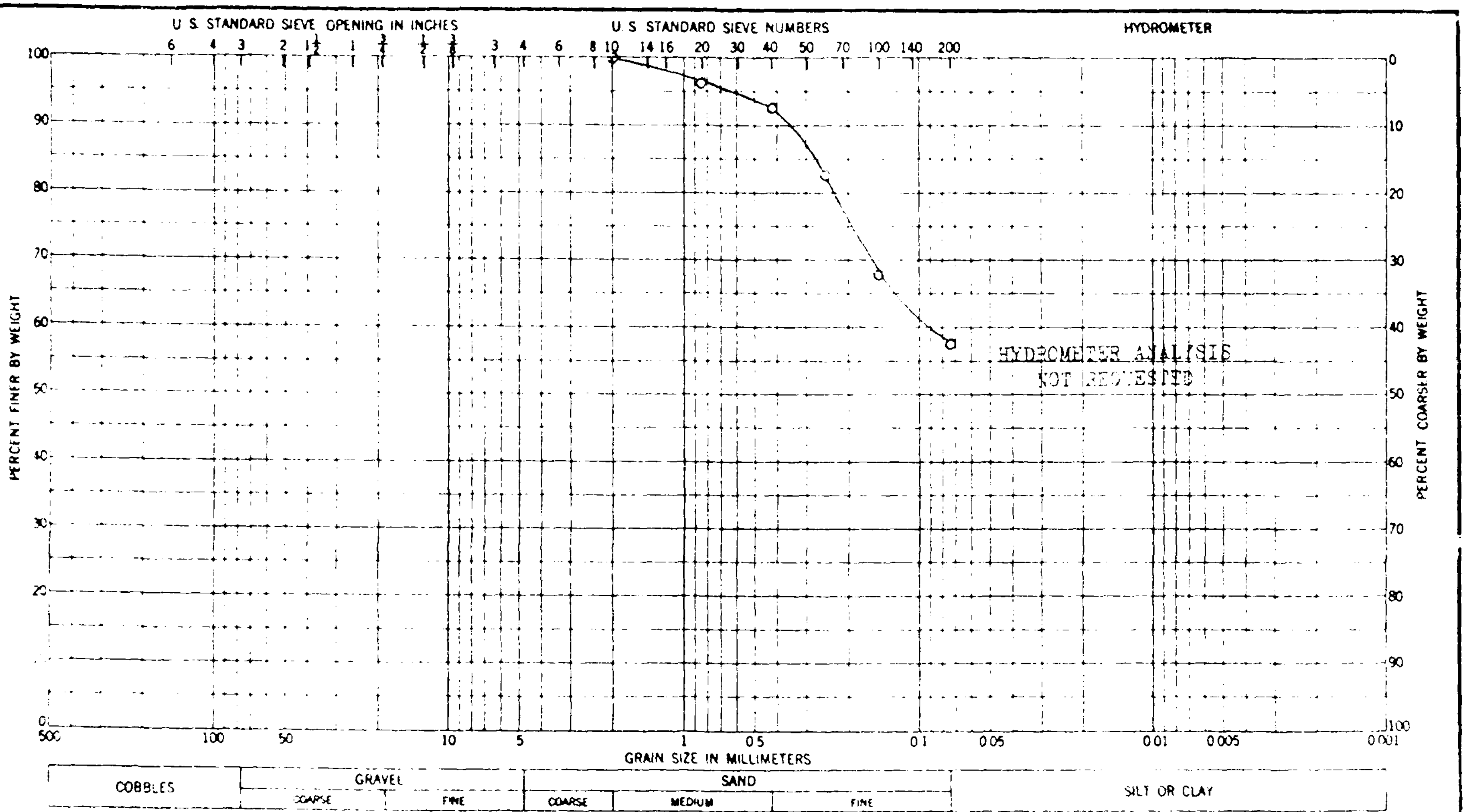
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	13.5-15.0'	Green sandy fat clay (CH)	33.0	56	24	32

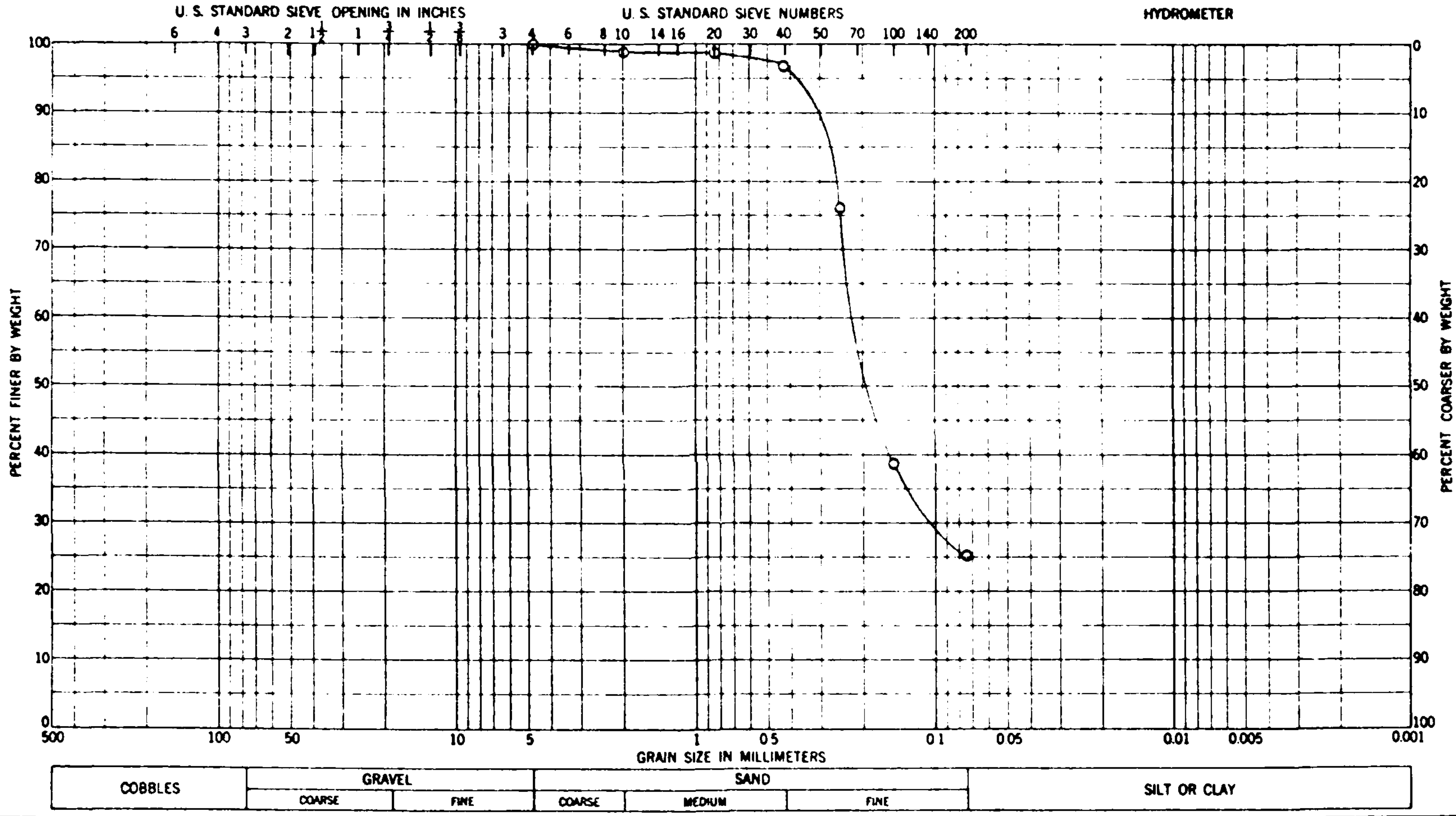
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4072
Area Cooling Water Facilities
Boring No. CS-5, Sample No. 4
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
8	27.0-28.5'	Green silty sand (SM)	27.2	NP	NP	NP

GRADATION CURVES

Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4076

Area Cooling Water Facilities

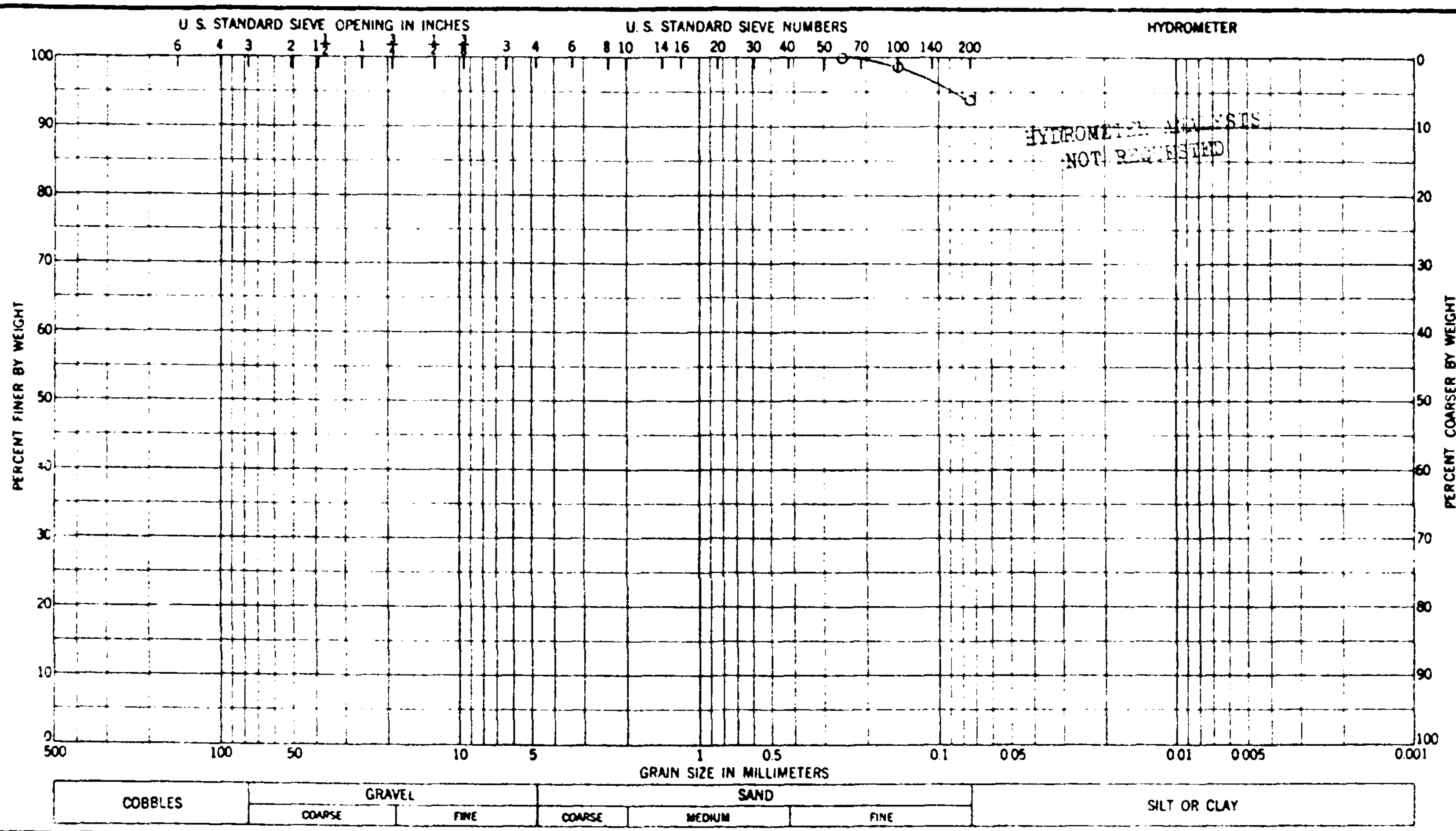
Boring No CS-5, Sample No. 8

Date 6 July 1979

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
10	33.0-34.5'	Green fat clay (CH) with a trace of sand	38.4	82	30	52

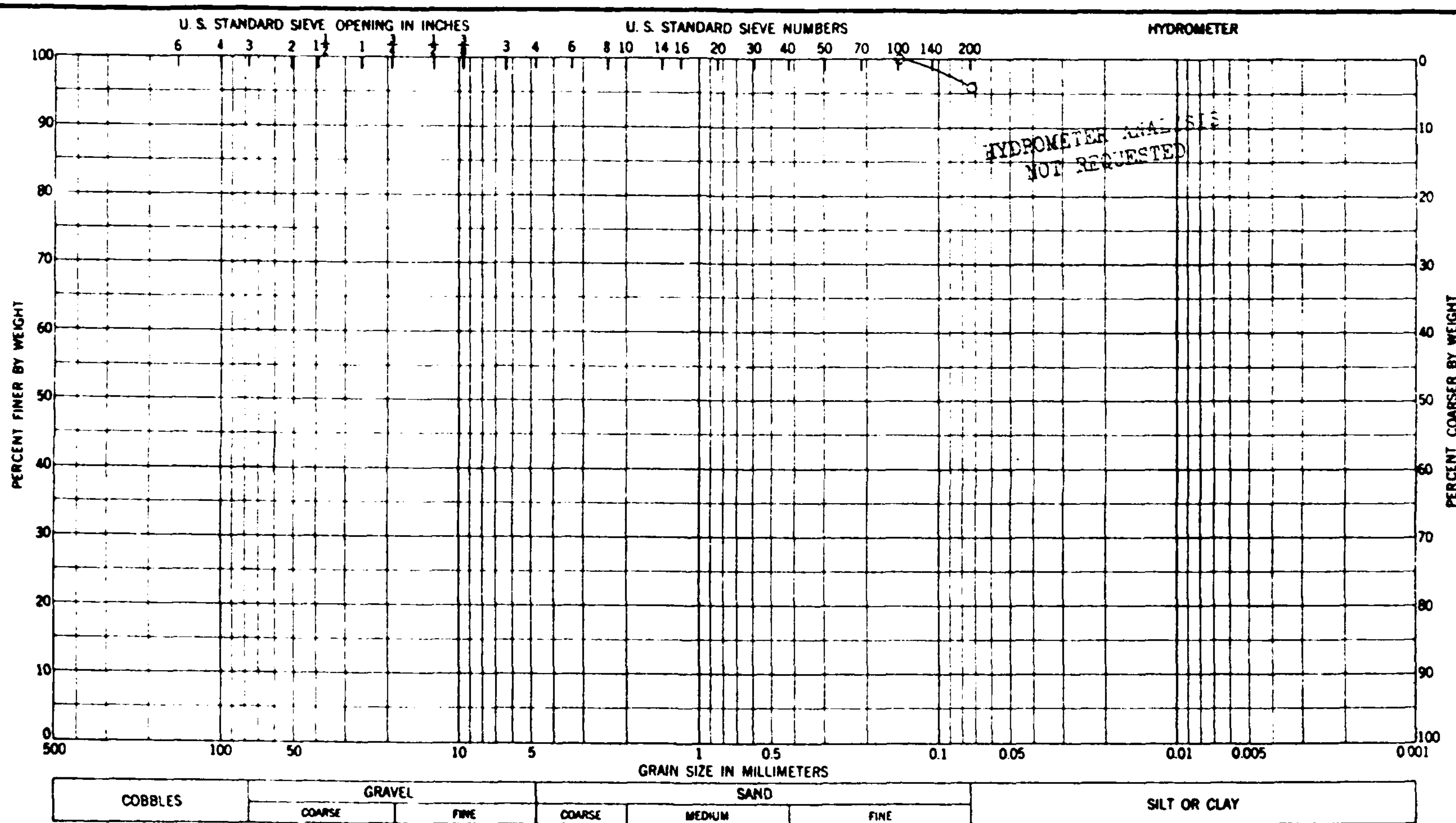
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4078
Area Cooling Water Facilities
Boring No. CS-5, Sample No. 10
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
11	36.0-37.5'	Green fat clay (CH) with a trace of sand	40.9	89	31	58

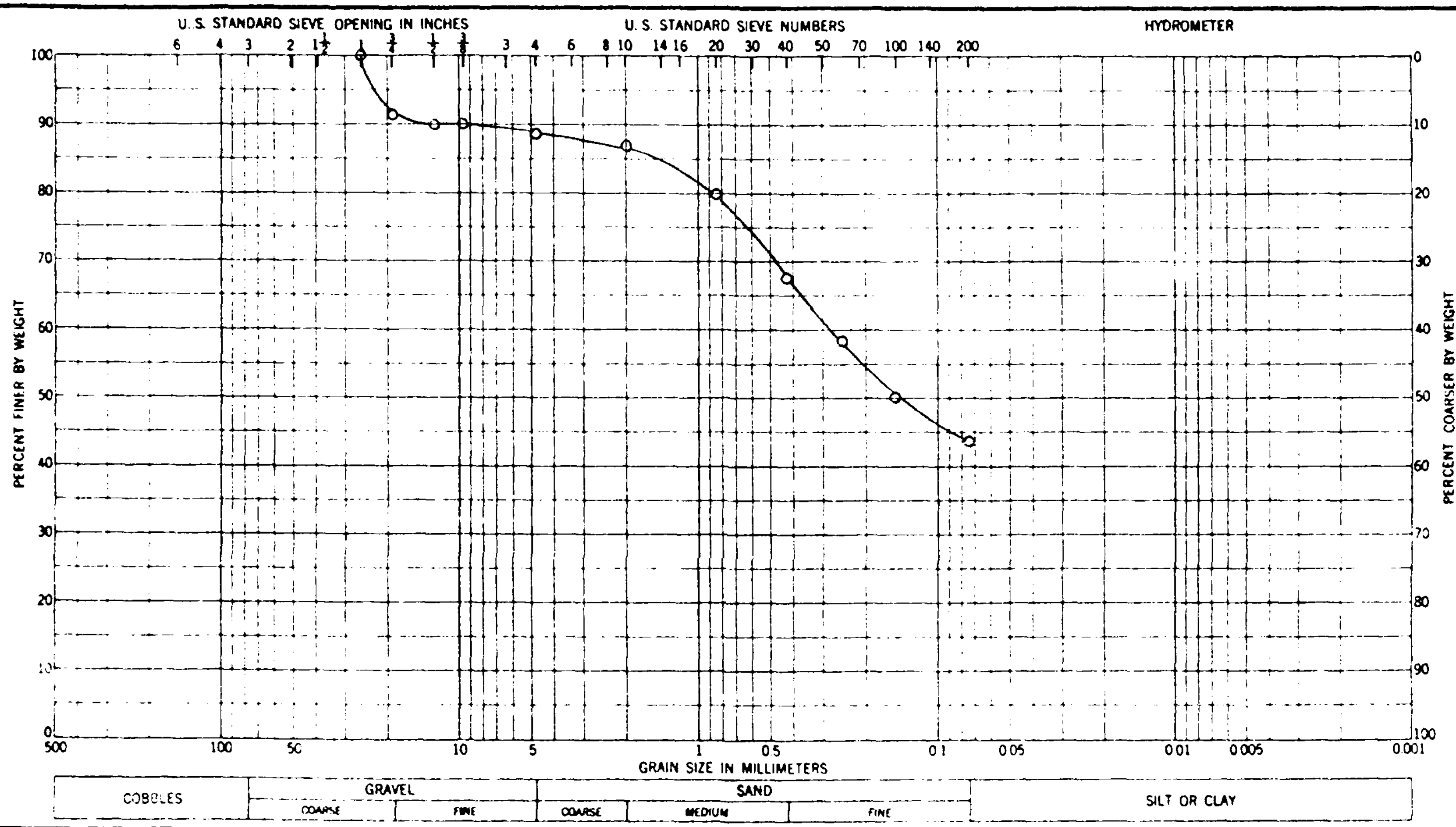
Project	SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
	Lab. No. 52/4079
Area	Cooling Water Facilities
Boring No.	CS-5, Sample No. 11
Date	6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	0.5-1.8'	Brown clayey sand, high LL, (SC-H) with a little gravel	14.9	52	18	34

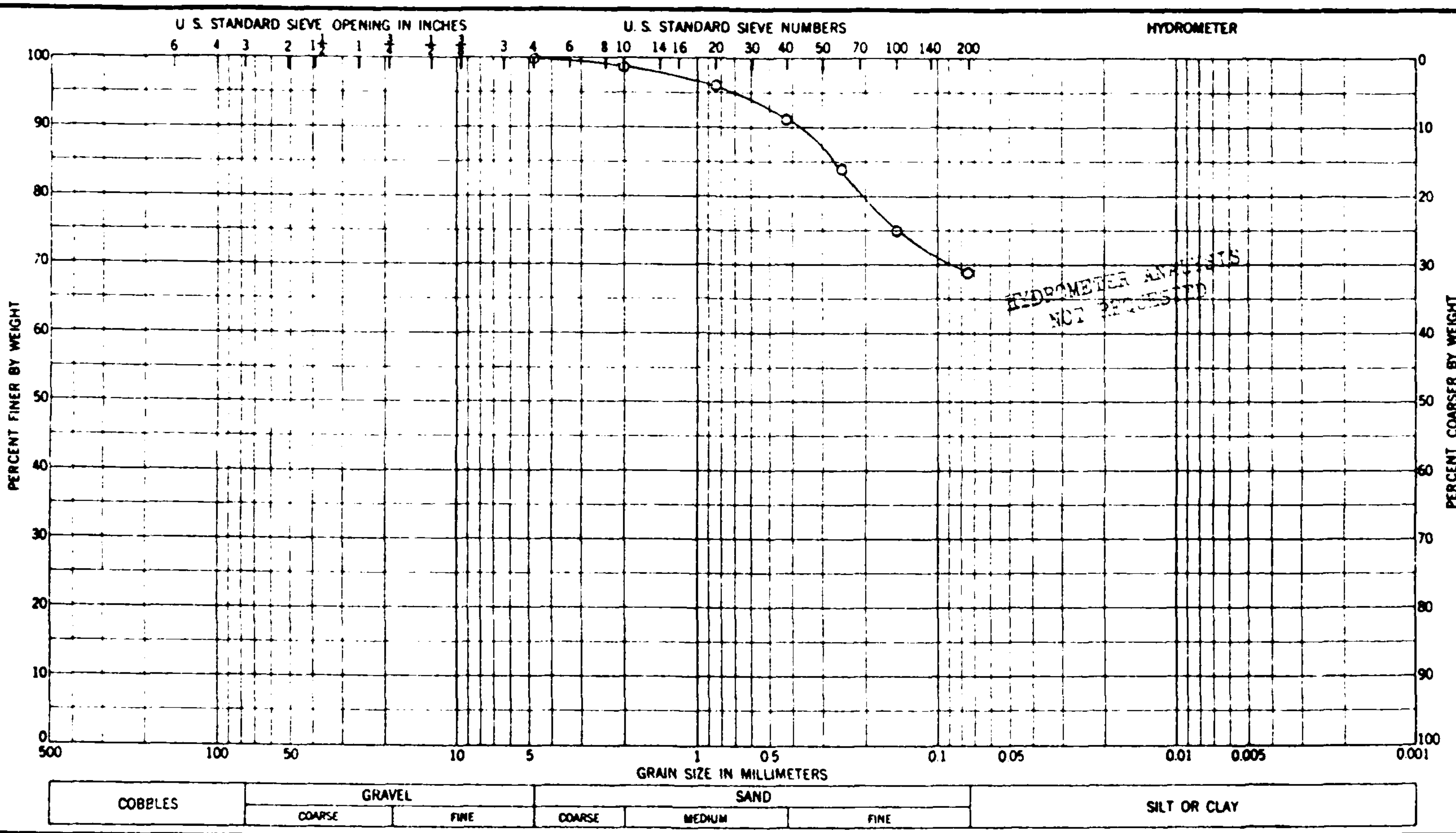
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4084
Area Cooling Water Facilities
Boring No. A-1, Sample No. 1
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	2.7-4.0'	Green fat clay (CH) with some sand	34.2	72	26	46

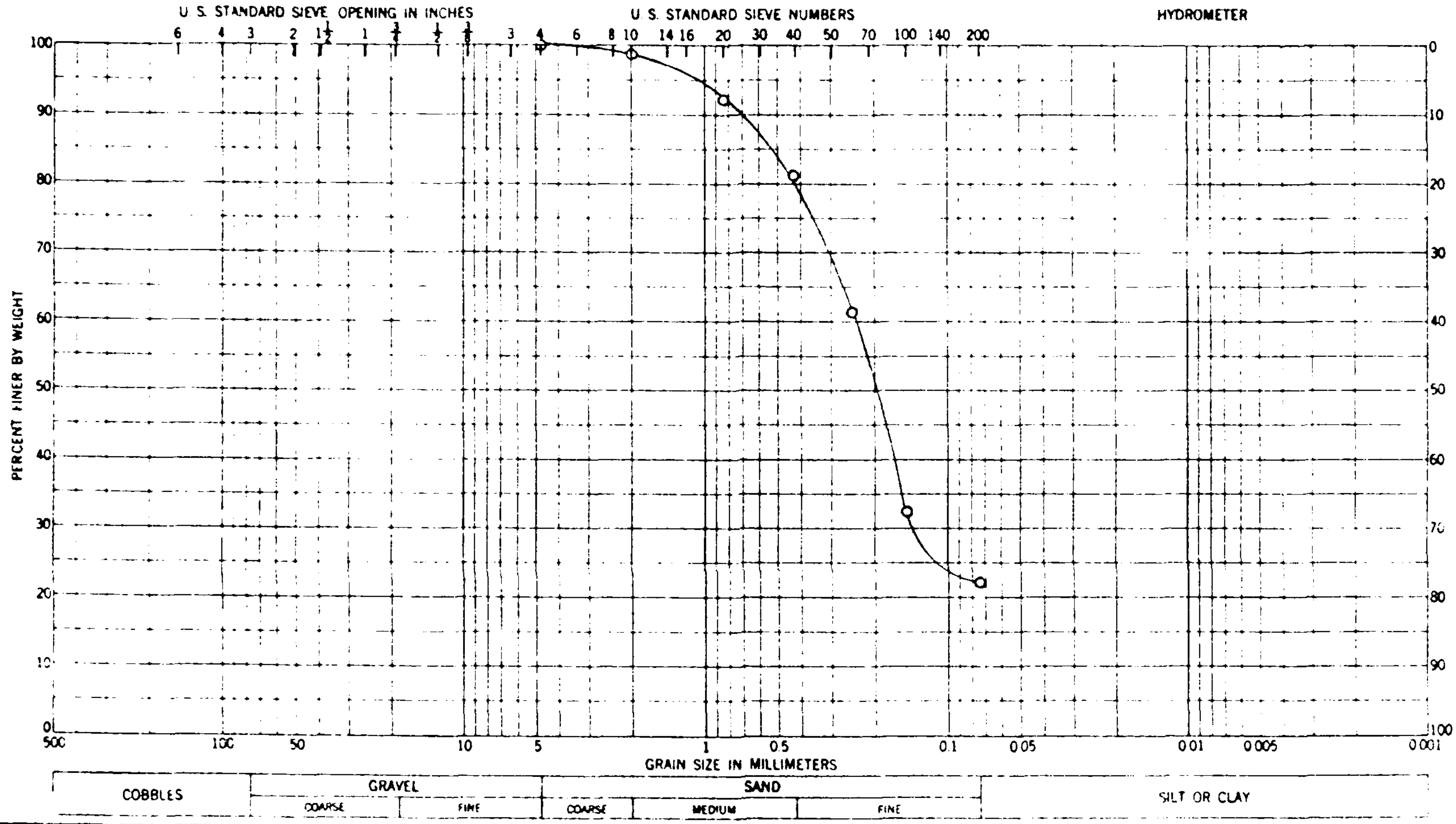
SAVANNAH DIST. Jefferies Steam
Project Plant, Moncks Corner, S.C.
Lab. No. 52/4086
Area Cooling Water Facilities
Boring No A-1, Sample No. 3
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	9.0-12.6'	Gray silty sand (SM)	15.3	NP	NP	NP

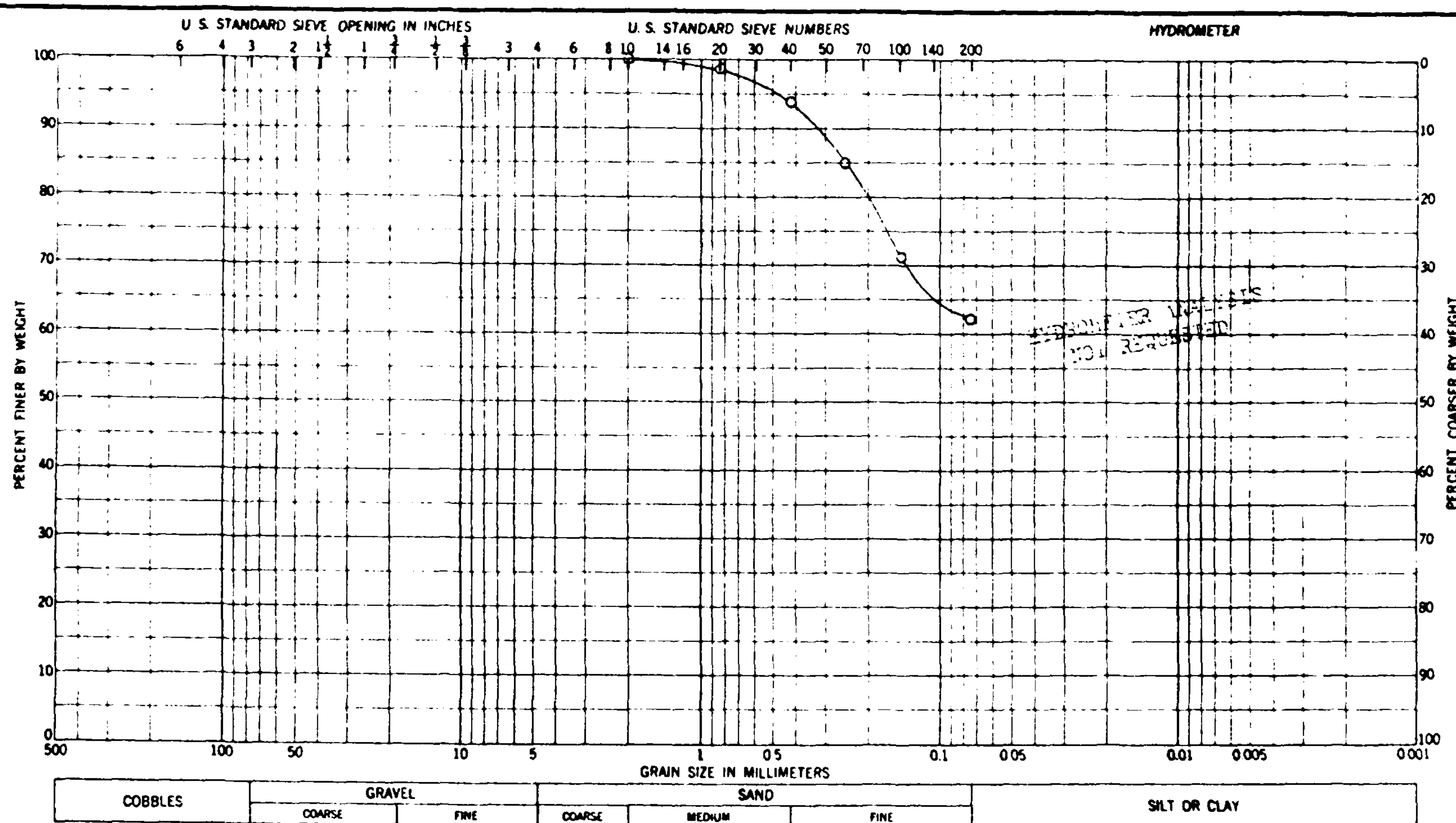
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4088
Area Cooling Water Facilities
Boring No A-1, Sample No. 5
Date 6 April 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2	2.0-4.2'	Gray sandy inorganic silt, low LL (ML)	25.5	NP	NP	NP

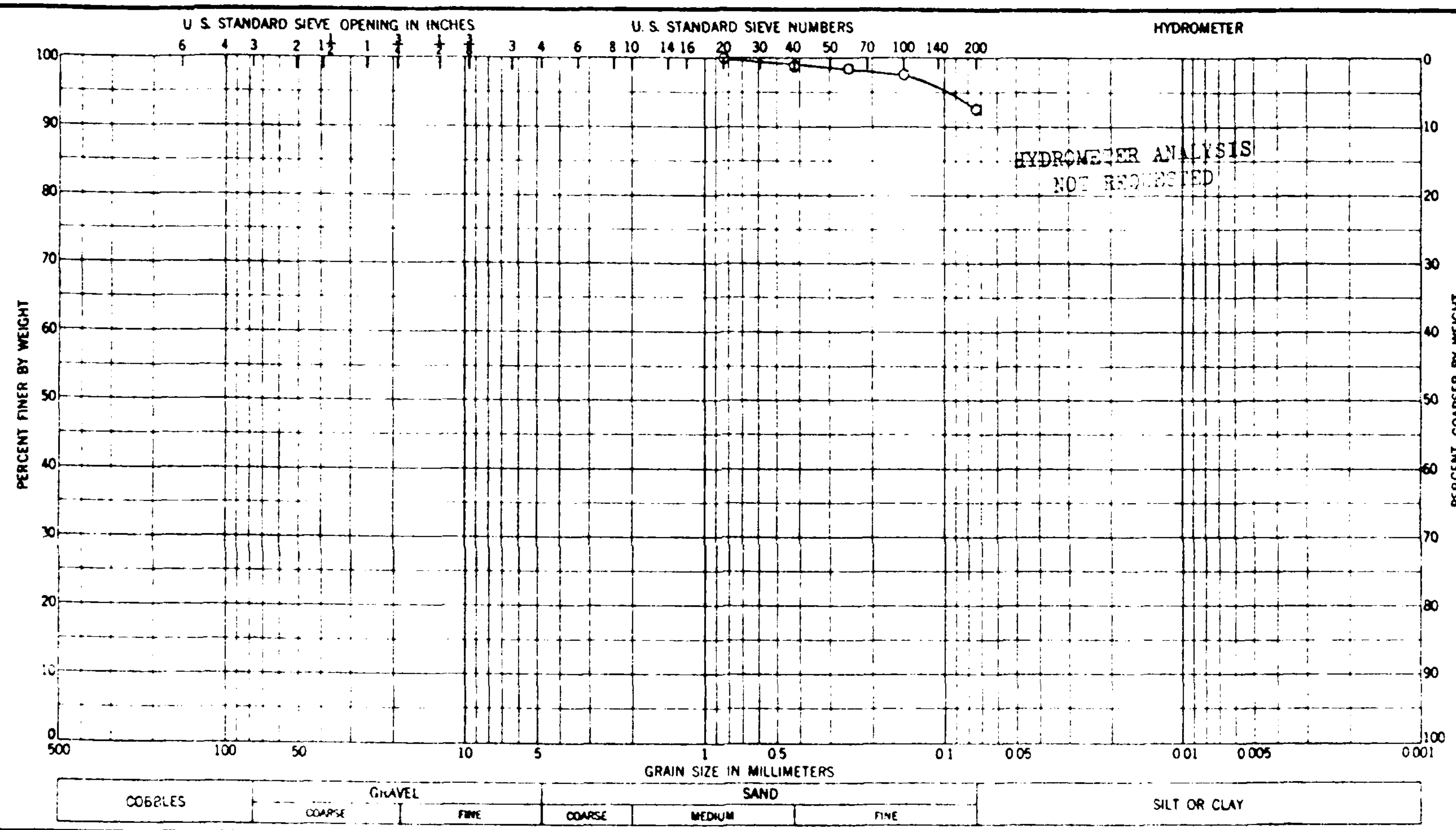
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4092
Area Cooling Water Facilities
Boring No. A-2, Sample No. 2
Date 6 July1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	5.0-13.2'	Green fat clay (CH) with a trace of sand	42.4	95	33	62

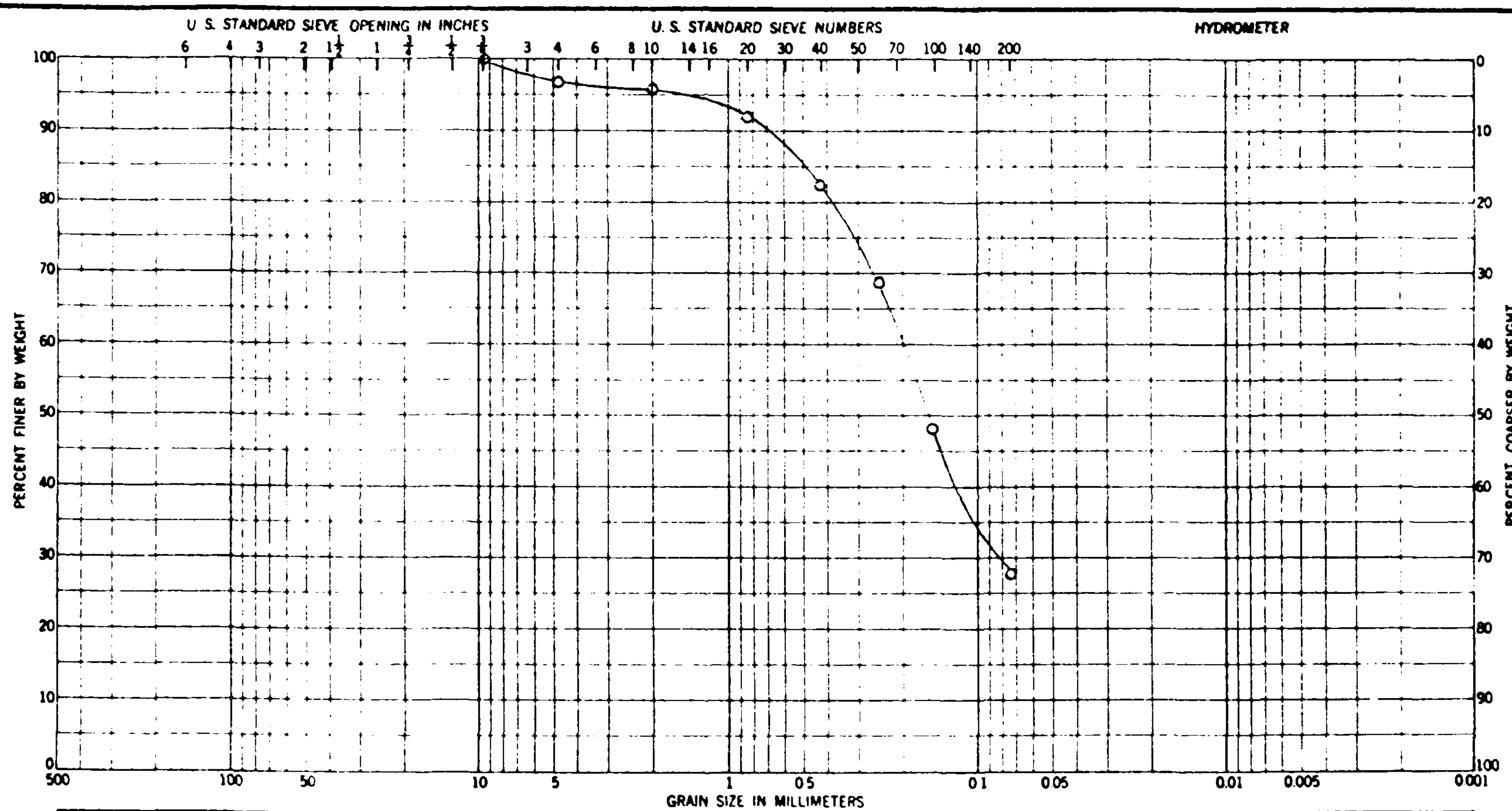
GRADATION CURVES

Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4094
Area Cooling Water Facilities
Boring No. A-2, Sample No. 4
Date 6 July 1979

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	13.2-14.5'	Black & gray slightly organic clayey sand (SC) with a trace of gravel sized roots	33.9	46	24	22
	Loss on	ignition, 2 hours at 600°C =	9.1%			

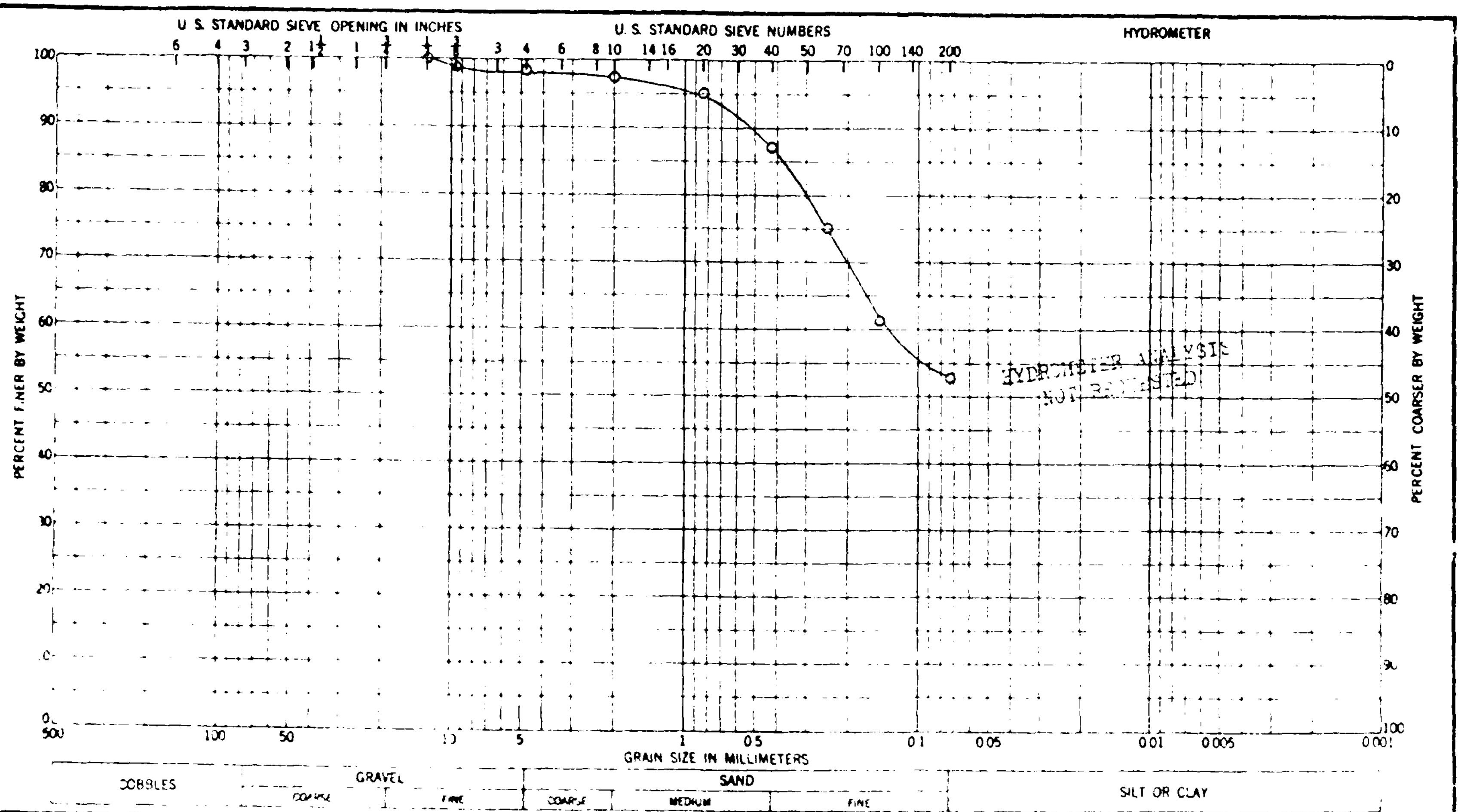
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4095
Area Cooling Water Facilities
Boring No. A-2, Sample No. 5
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	0.0-1.5'	Brown sandy lean clay (CL) with a trace of gravel	22.5	48	21	27

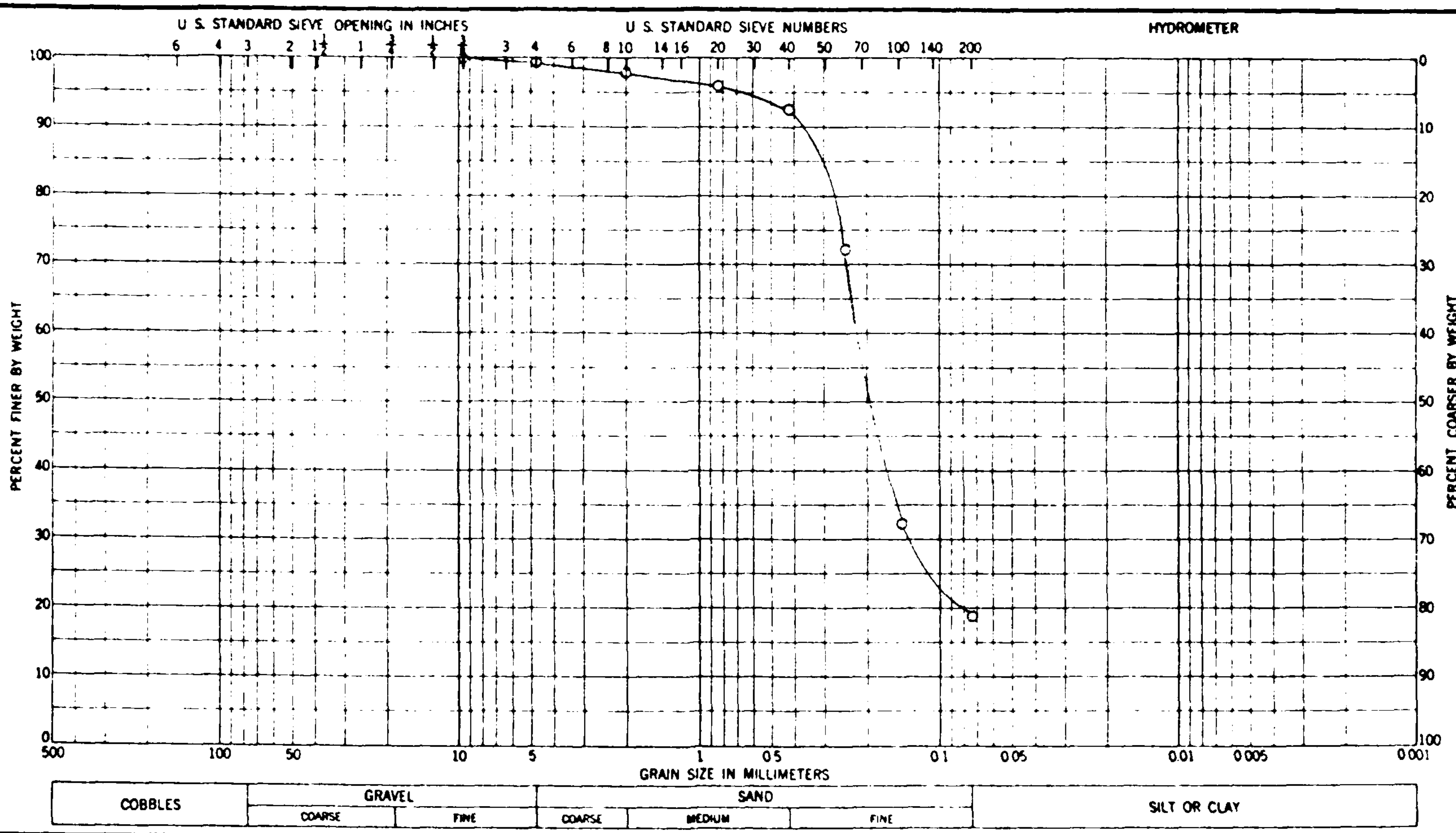
Project: SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4097
Area: Cooling Water Facilities
Boring No.: A-3, Sample No. 1
Date: 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	2.3-4.3'	Brown silty sand (SM)	24.2	NP	NP	NP

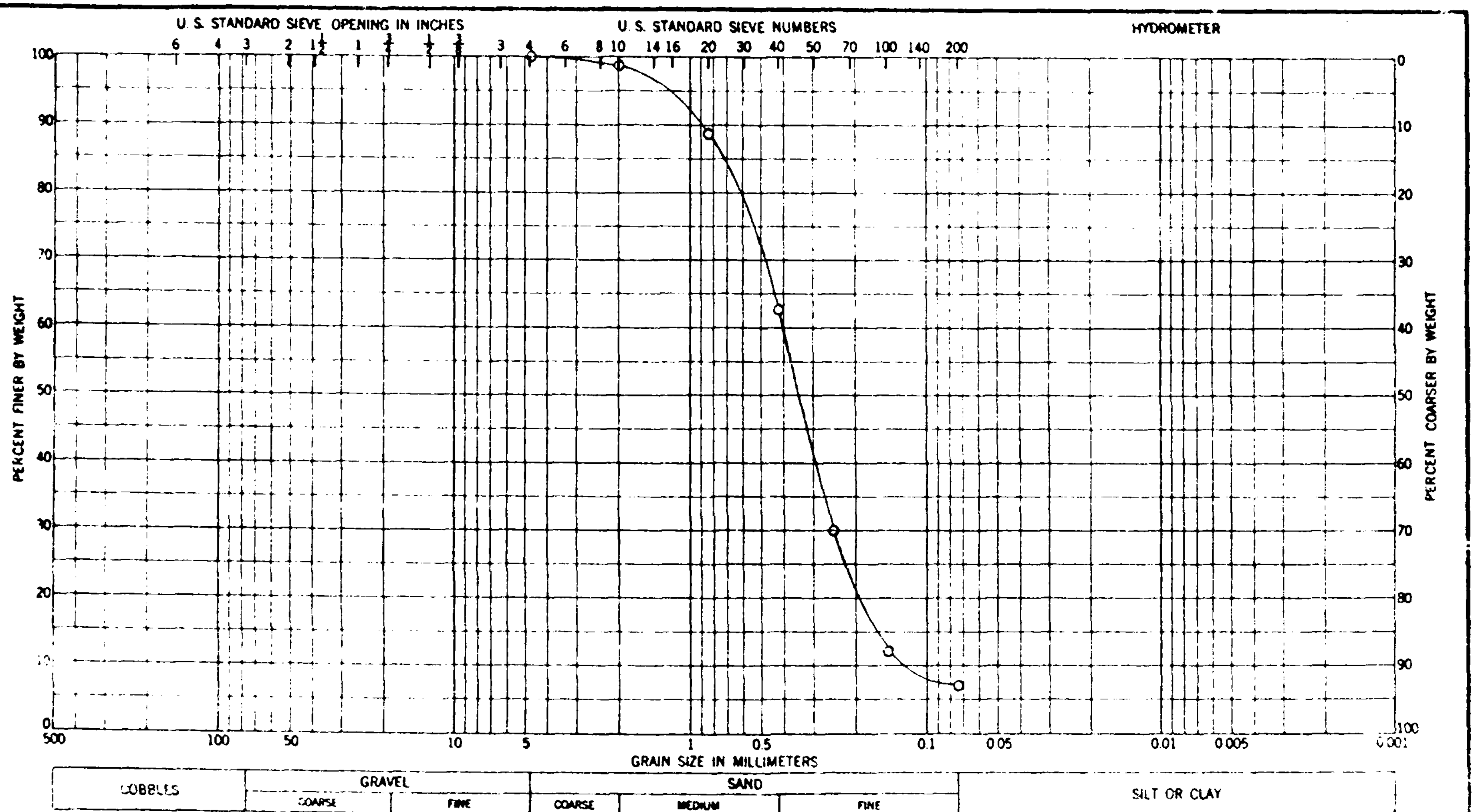
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4099
Area Cooling Water Facilities
Boring No. A-3, Sample No. 3
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
7	8.0-11.5'	Tan poorly graded silty sand (SP-SM)	18.1	NP	NP	NP

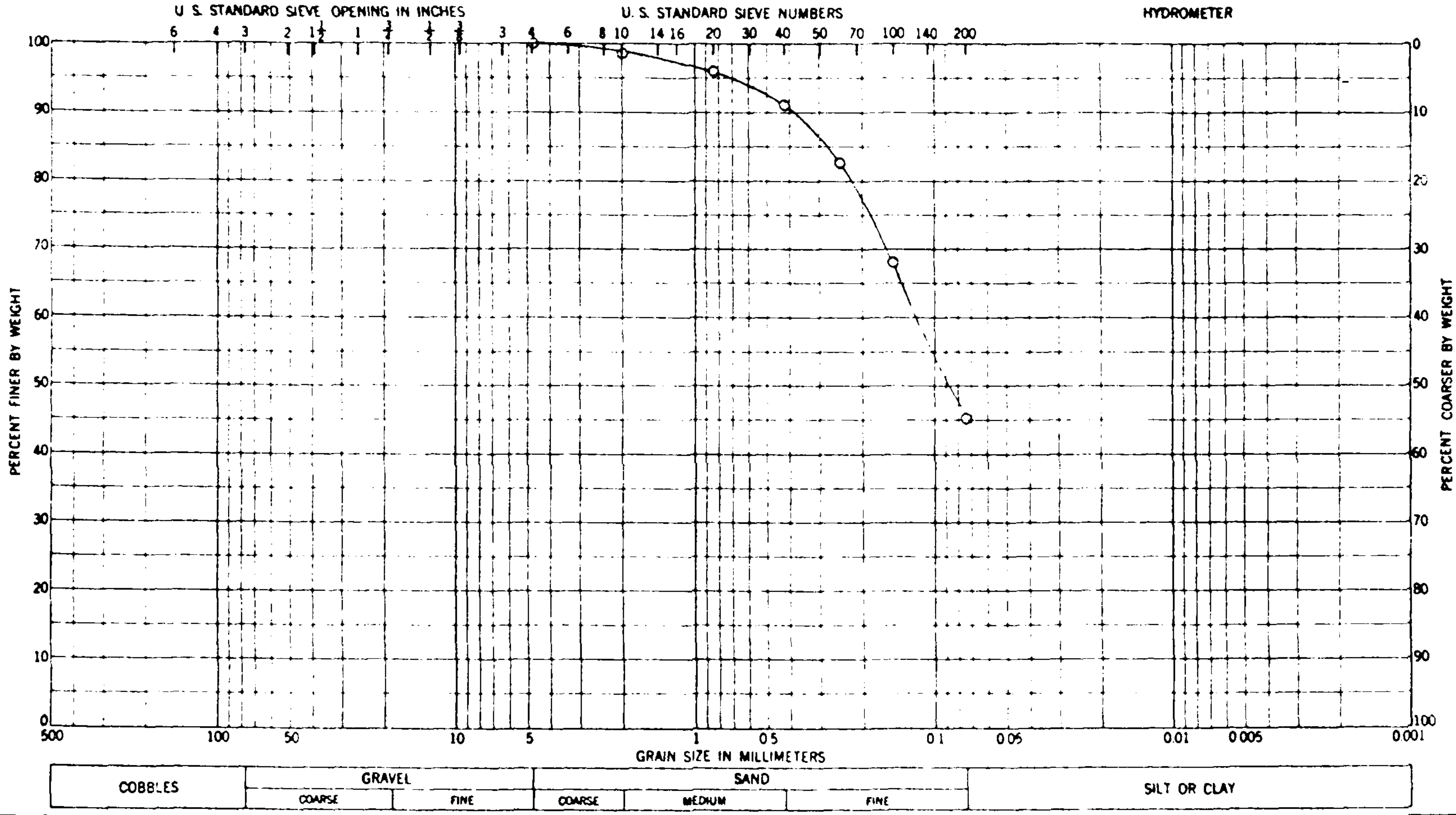
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4103
Area Cooling Water Facilities
Boring No. A-3, Sample No. 7
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
4	16.4-17.5'	Gray clayey sand (SC) with a trace of roots	30.8	48	15	33

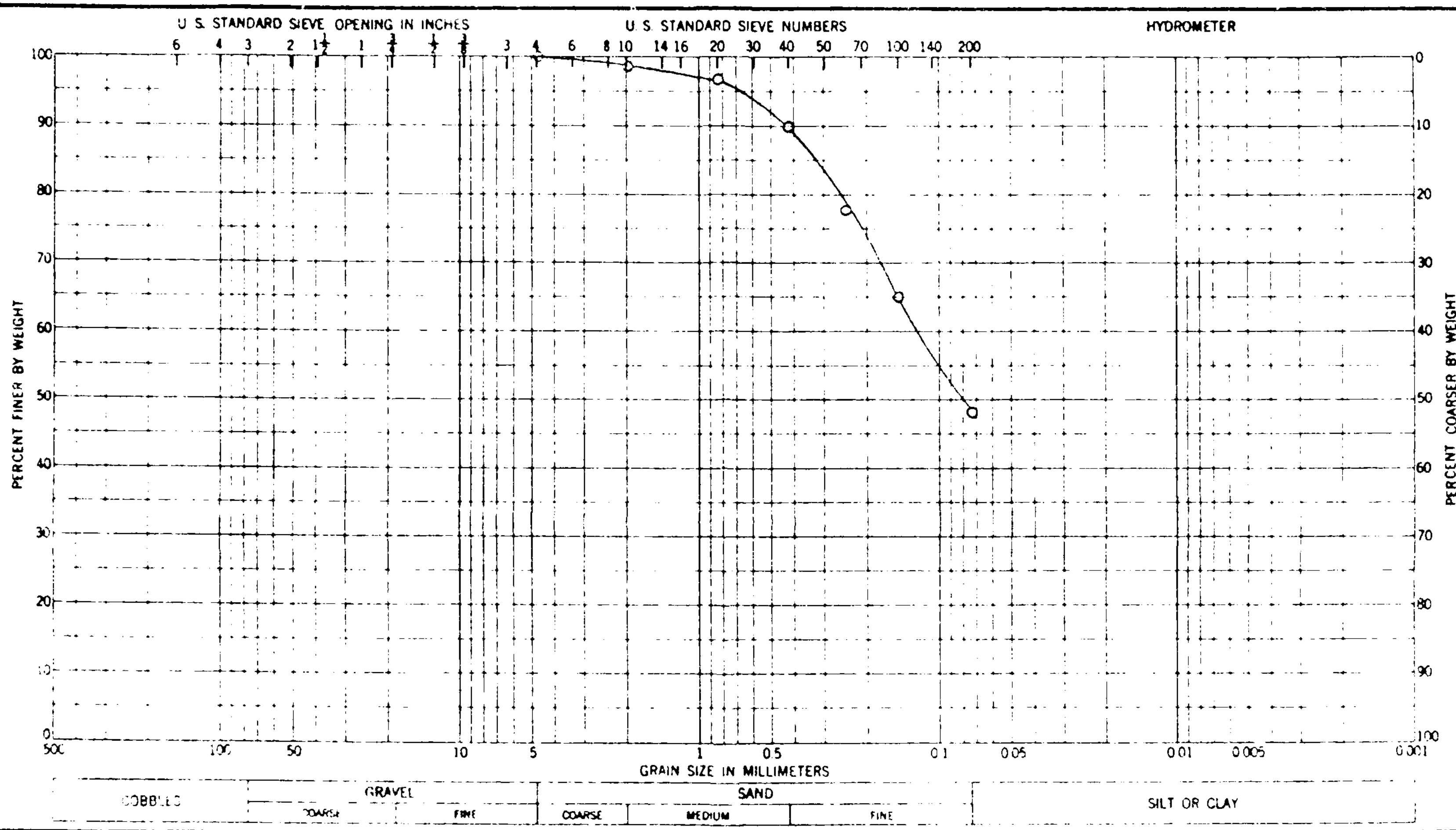
Project SAVANNAH Dist. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4108
Area Cooling Water Facilities
Boring No A-4, Sample No. 4
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	17.5-19.0'	Gray clayey sand, high LL, (SC-H)	20.4	*55	29	*26
		*Plots on "A" Line				

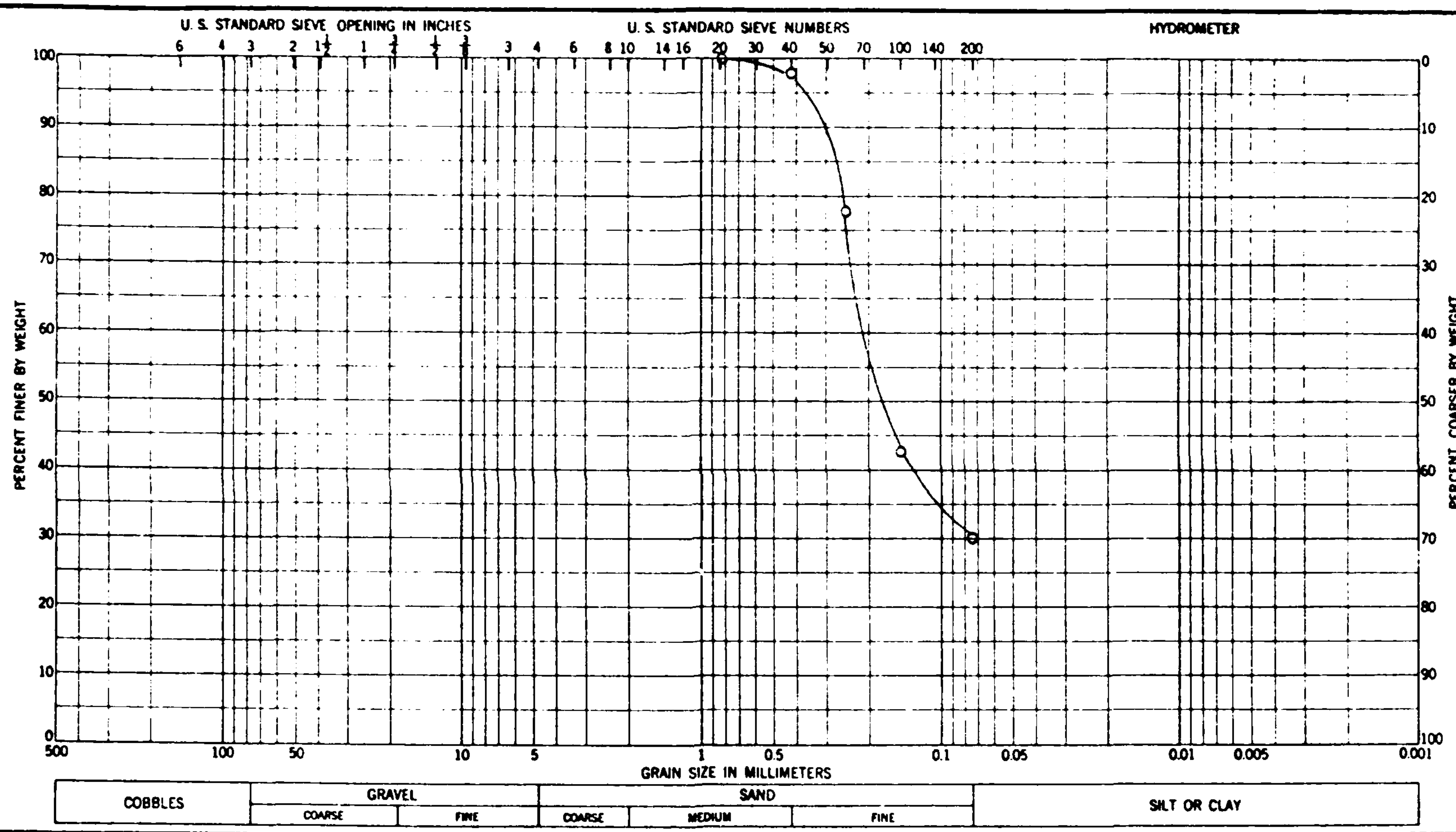
Project: SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4109
Area: Cooling Water Facilities
Boring No. A-4, Sample No. 5
Date: 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
9	25.5-29.7'	Green silty sand (SM)	24.8	NP	NP	NP

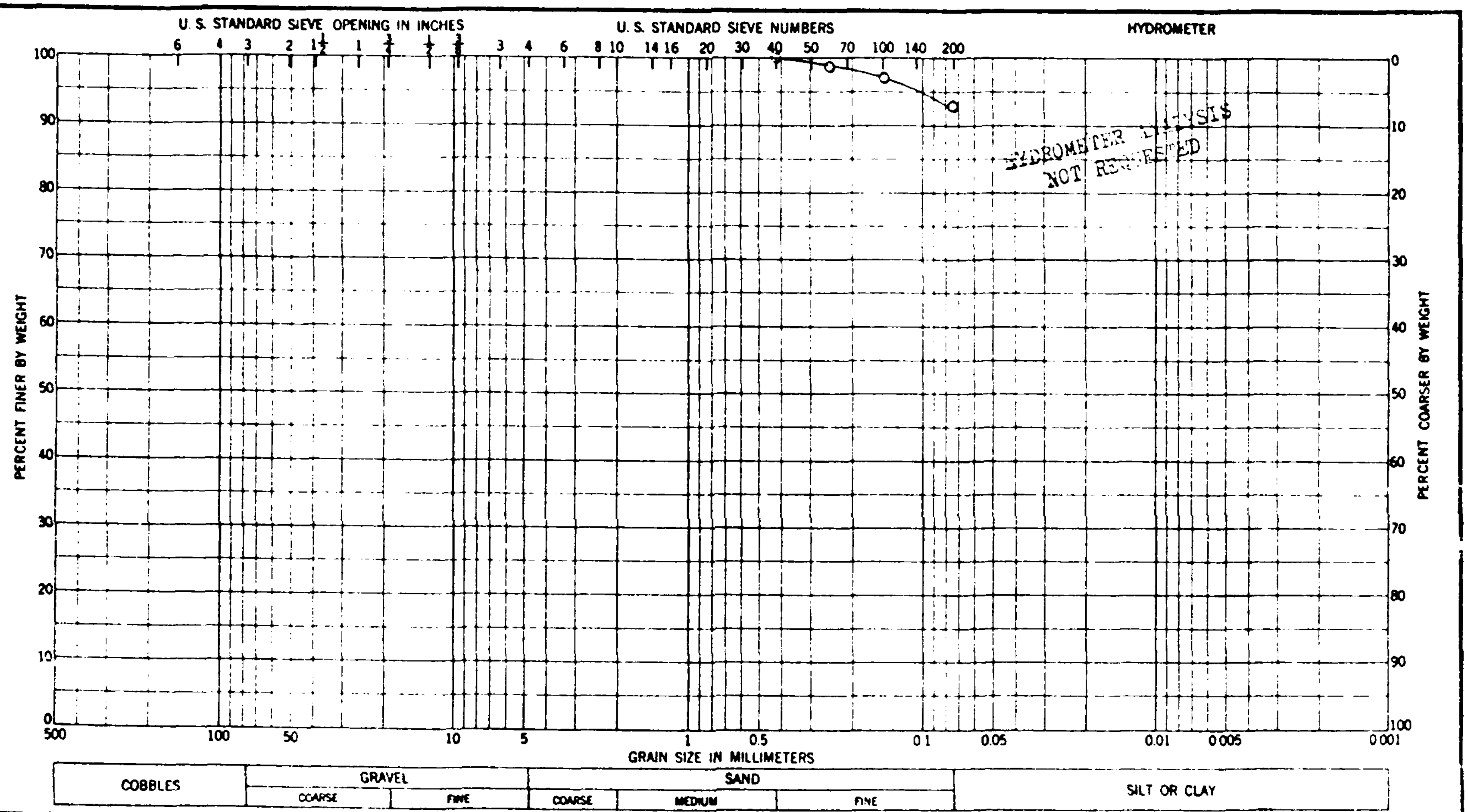
Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4113
Area Cooling Water Facilities
Boring No. A-4, Sample No. 9
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
10	29.7-43.0'	Green fat clay (CH) with a trace of sand	39.1	88	27	61

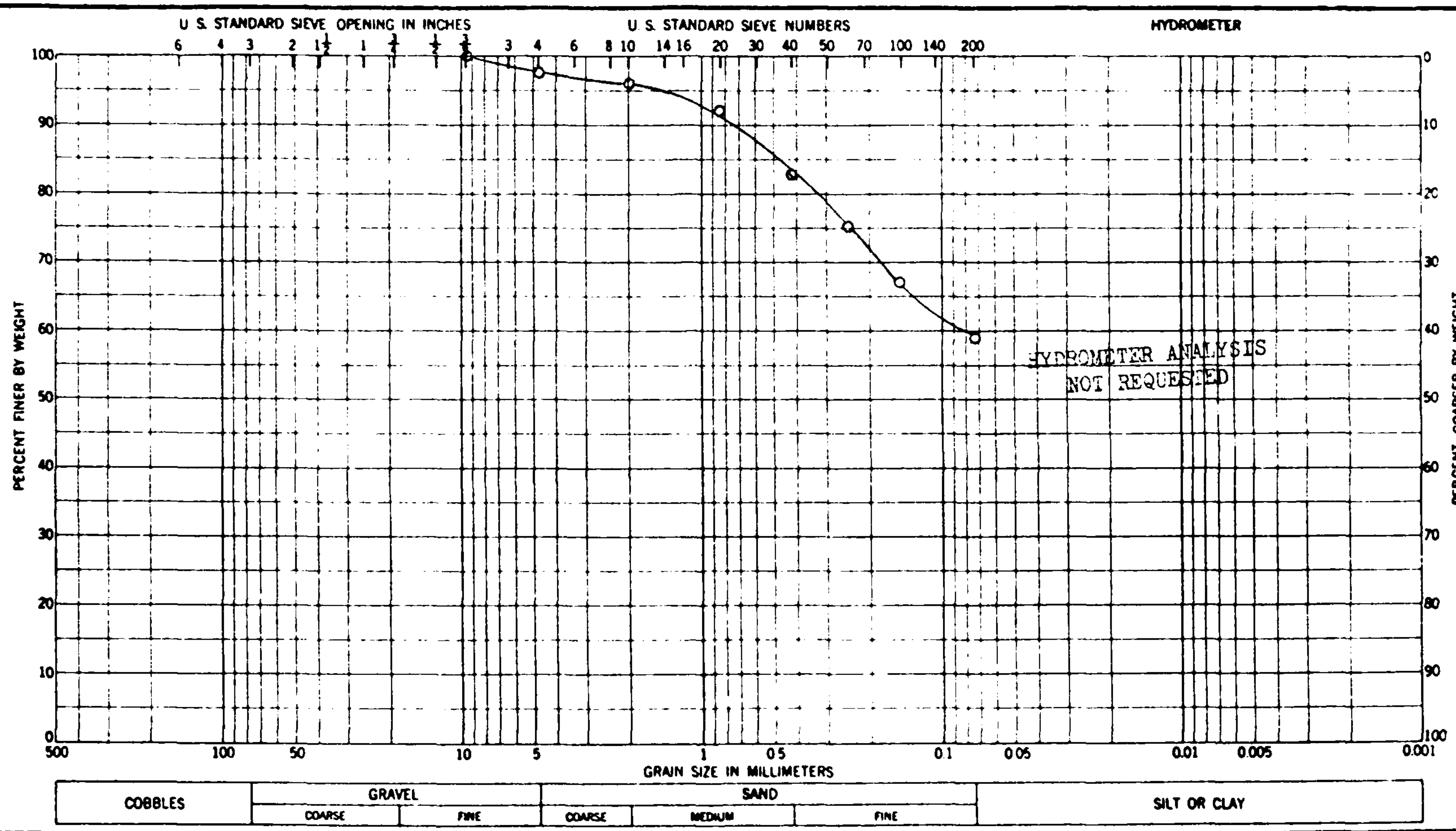
Project: SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4114
Area: Cooling Water Facilities
Boring No. A-4, Sample No. 10
Date: 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1	0.0-1.6'	Brown sandy fat clay (CH) with a trace of gravel	31.0	66	23	43

Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4116

Area Cooling Water Facilities

Boring No. A-5, Sample No. 1

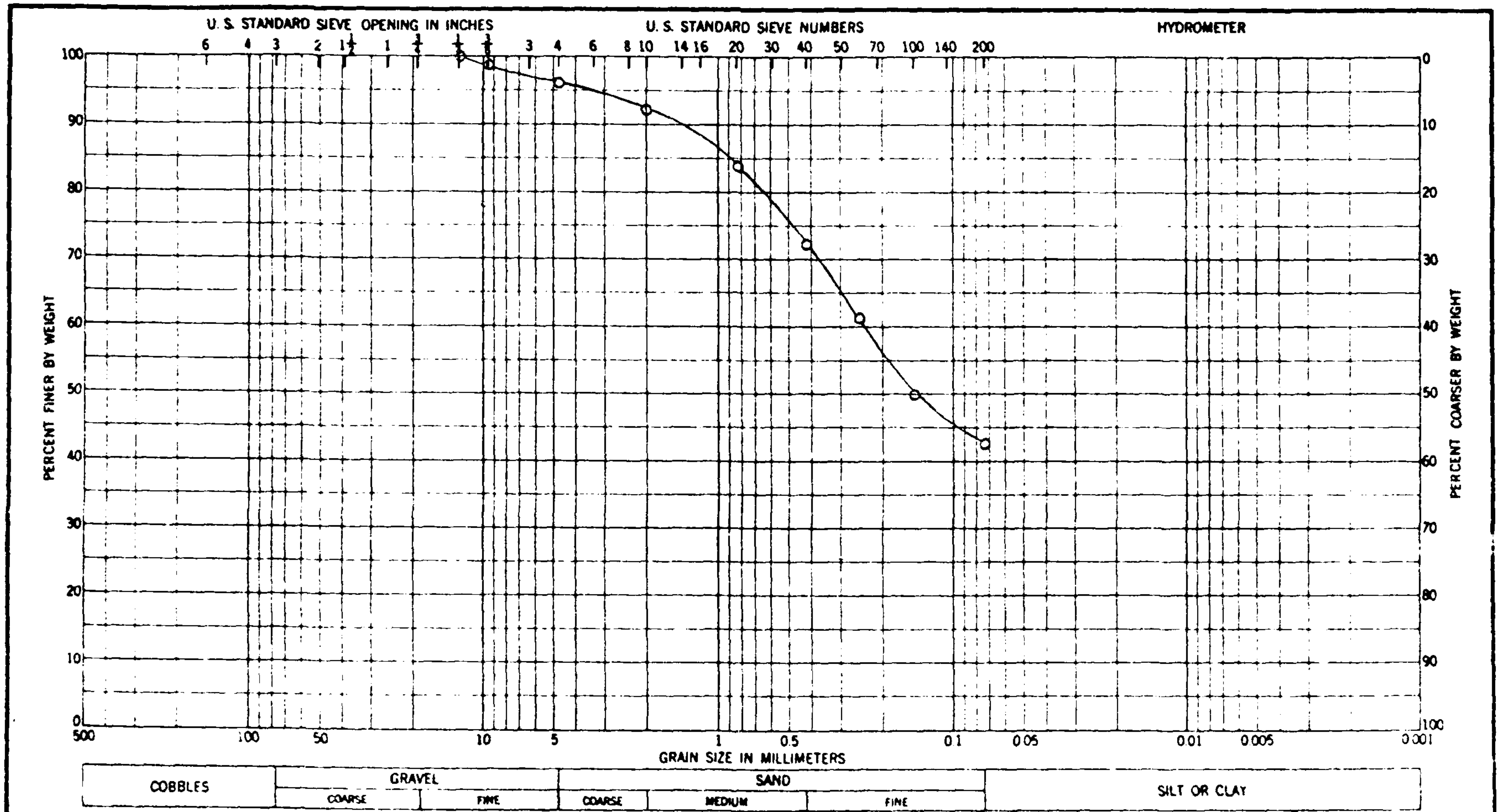
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	5.0-5.0	Brown clayey sand, high LL, (SC-H) with a trace of gravel	24.6	55	20	35

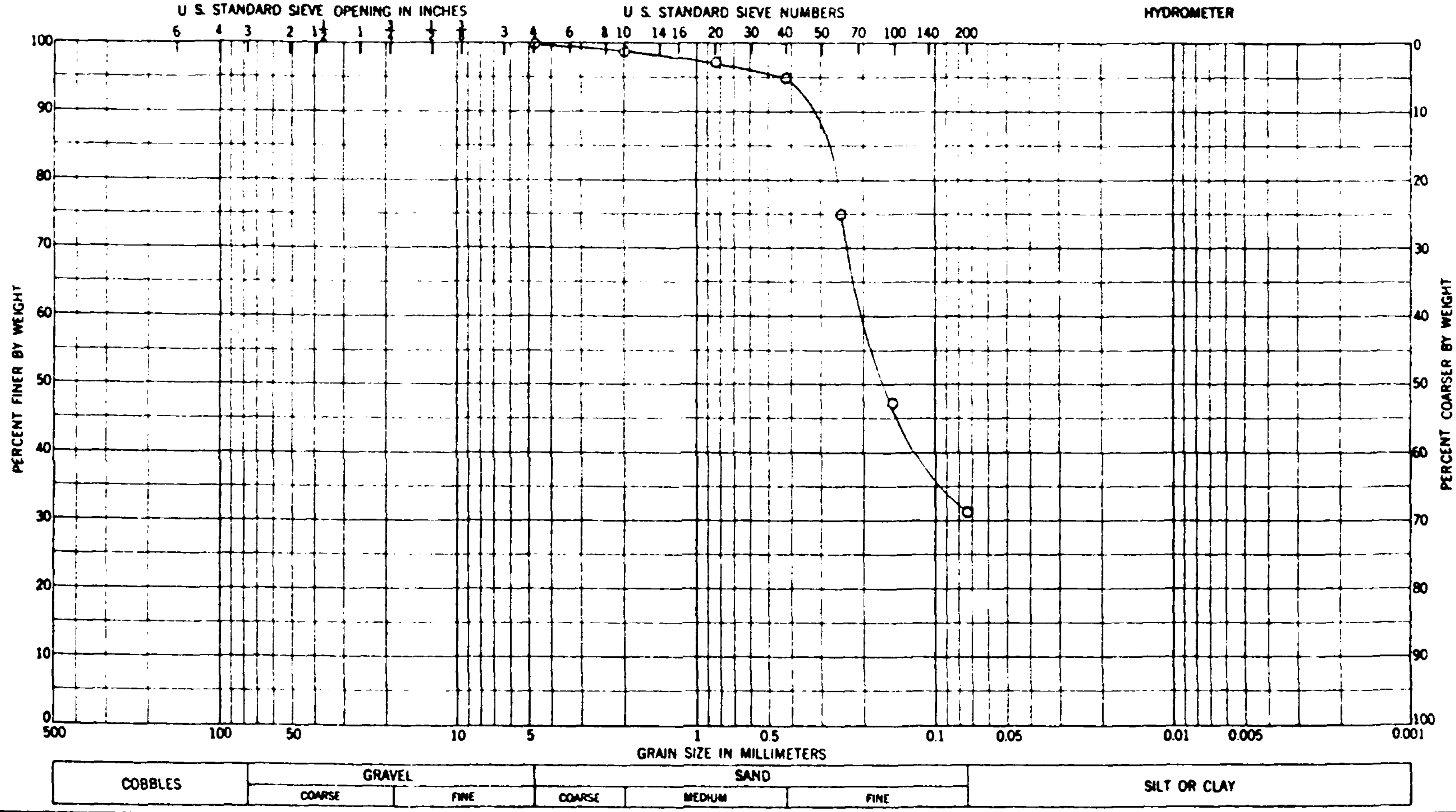
GRADATION CURVES

Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4118
Area Cooling Water Facilities
Boring No. A-5. Sample No. 3
Date 6 July 1979

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
6	12.2-13.5'	Green clayey sand (SC)	29.2	41	23	18

Project: SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.

Lab. No. 52/4121

Area: Cooling Water Facilities

Boring No.: A-5, Sample No. 6

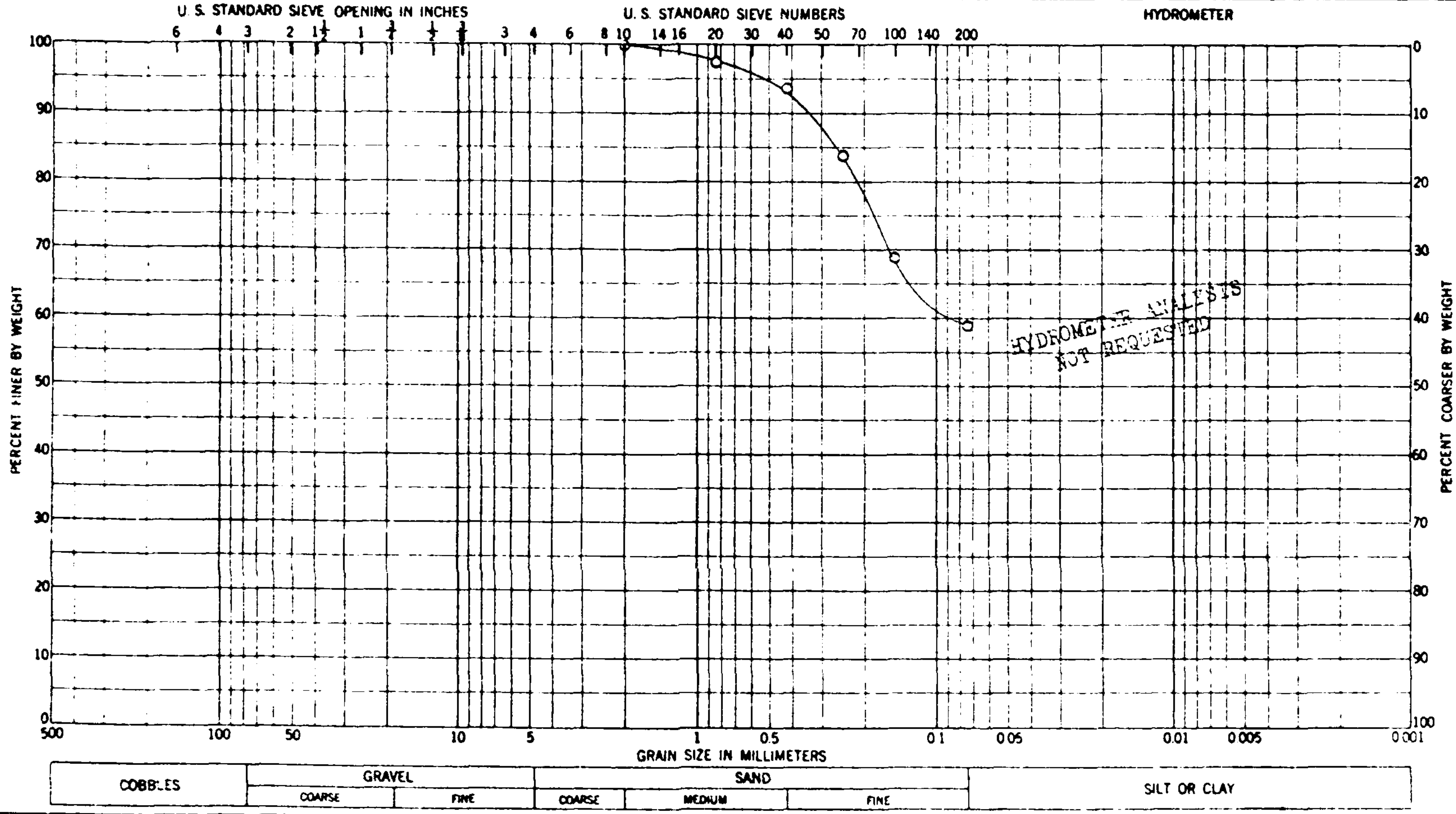
Date: 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
7	13.5-14.5'	Green sandy fat clay (CH) with a trace of roots	33.9	65	24	41

Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.

Lab. No. 52/4122

Area Cooling Water Facilities

Boring No. A-5, Sample No. 7

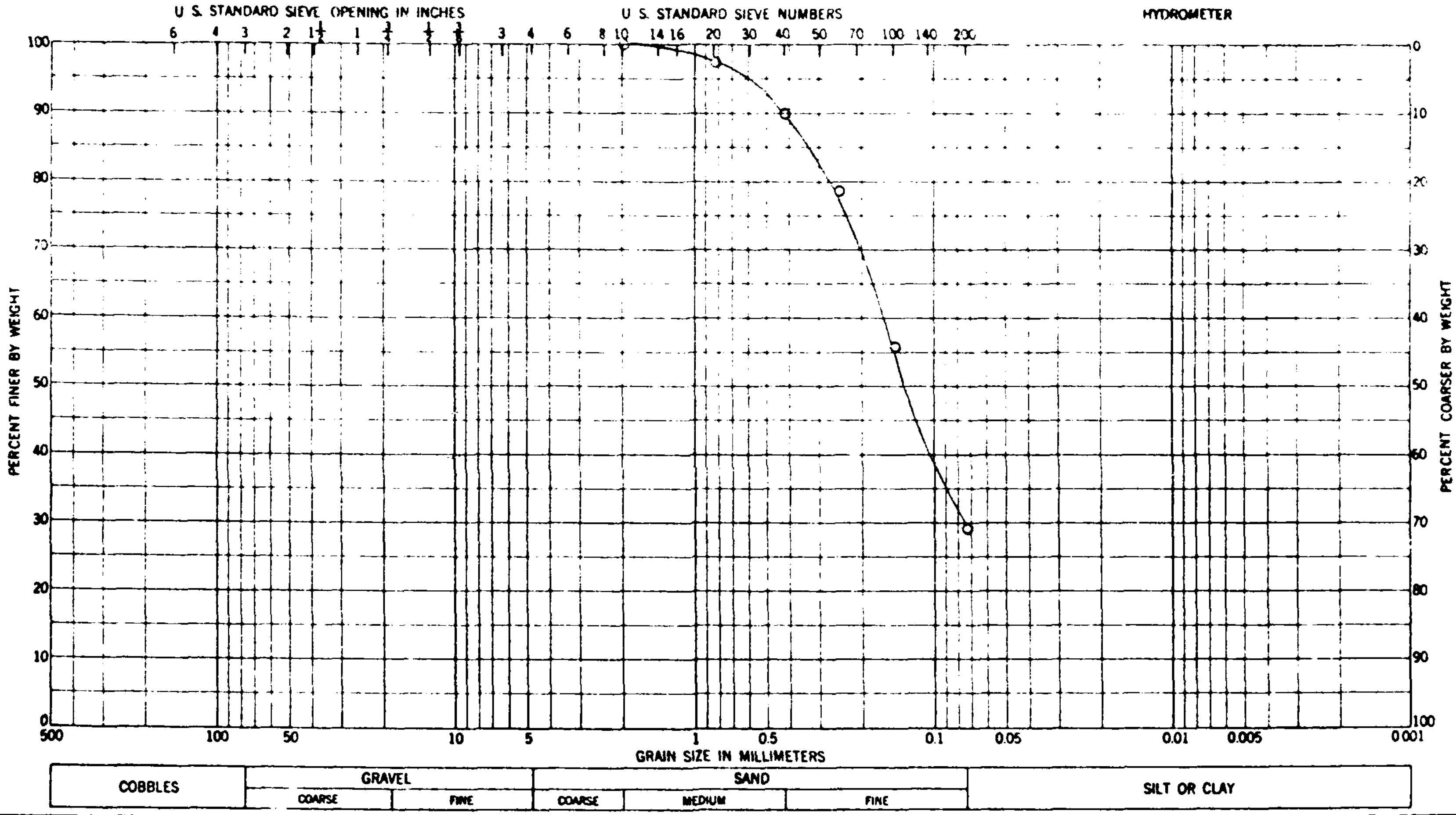
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
8	14.5-16.2'	Dark gray silty sand (SM) with a trace of roots	24.6	35	27	8

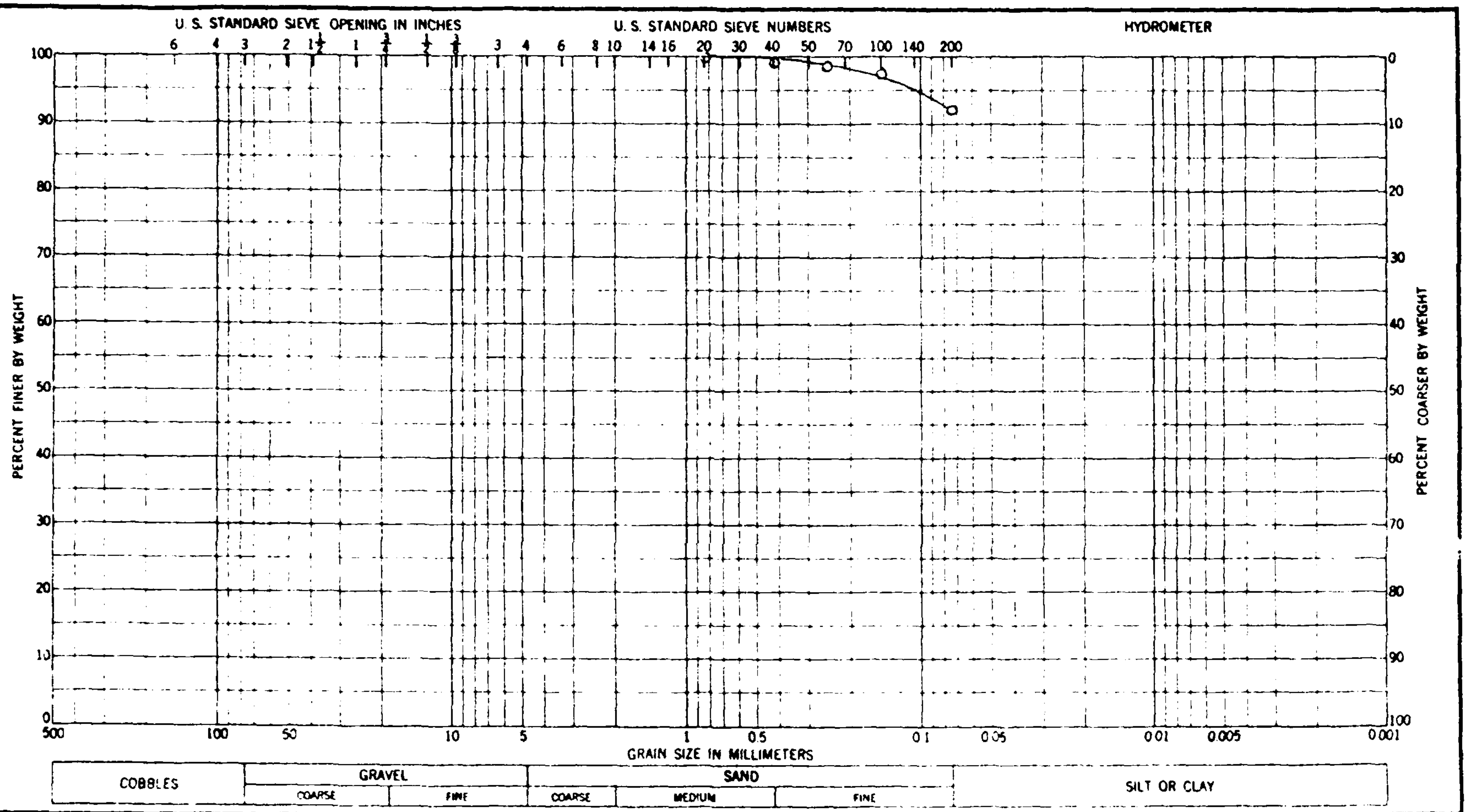
GRADATION CURVES

Project: SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4123
Area: Cooling Water Facilities
Boring No. A-5, Sample No. 8
Date: 6 July 1979

ENG FORM 1 MAY 63 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. 1862
Req. No. EN-FS-79-156



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
11	27.9-46.0'	Green fat clay (CH) with a trace of sand	37.8	80	26	54

Project SAVANNAH DIST. Jefferies Steam Plant, Moncks Corner, S.C.
Lab. No. 52/4126
Area Cooling Water Facilities
Boring No A-5, Sample No. 11
Date 6 July 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087


PINOPOLIS LOCKS
JEFFERIES HYDRO
JEFFERIES STEAM PLANT
PROPOSED PUMP STATION LOCATION
OIL STORAGE TANKS
PROPOSED COOLING TOWER LOCATION
RAILROAD
TAILRACE

2

U S ARMY ENGINEER DISTRICT, SAVANNAH CORPS OF ENGINEERS SAVANNAH, GEORGIA	STANLEY CONSULTANTS INC CONSULTING ENGINEERS ATLANTA GEORGIA

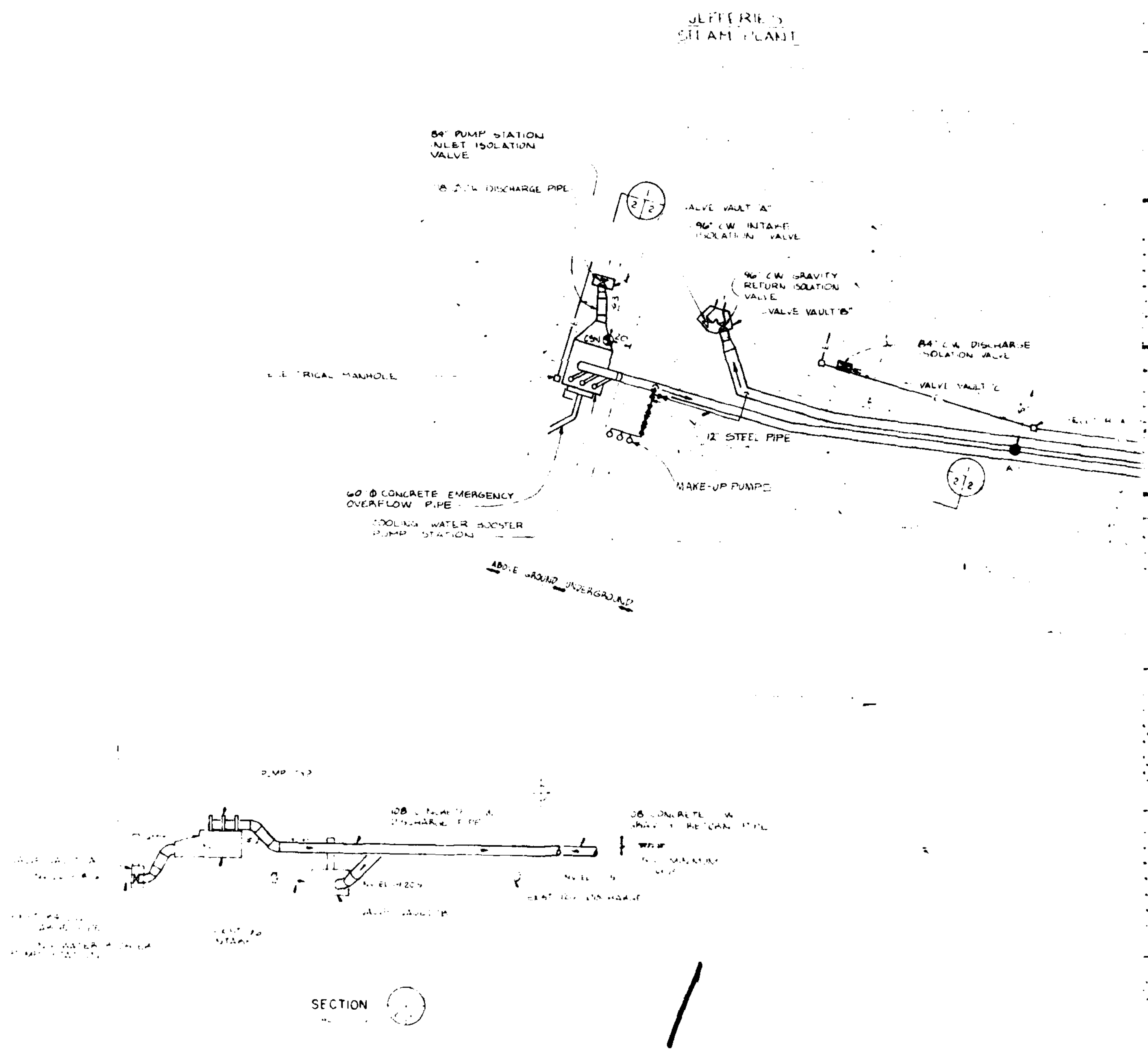
DESIGN MEMORANDUM 13
COOLING WATER FACILITIES

LOCATION PLAN

COOPER RIVER REDIVERSION PROJECT
LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA

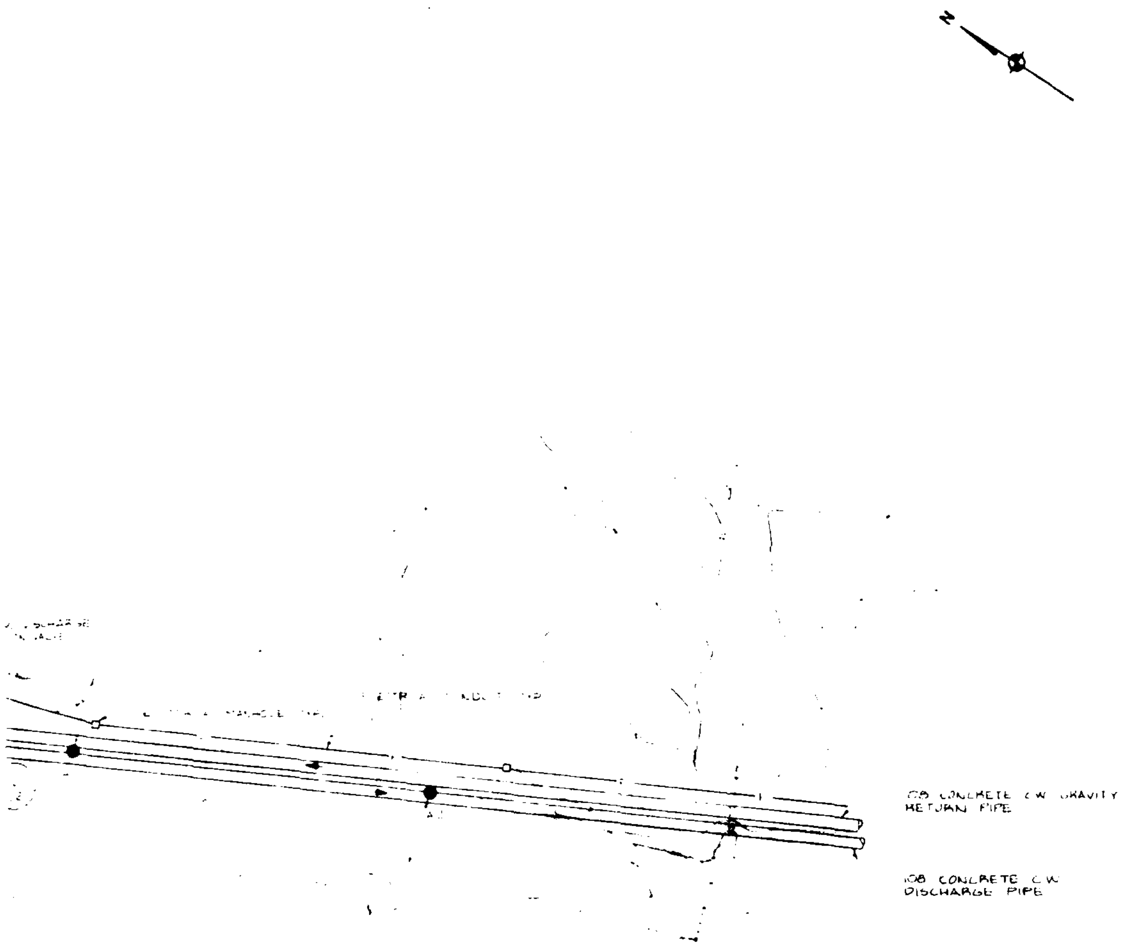
SUBMITTED CHIEF, MECHANICAL SECTION	RECOMMENDED CHIEF, DESIGN BRANCH
APPROVED CHIEF, ENGINEERING DIVISION	APPROVED COL, C E

SCALE NONE	DATE 22 SEP 80	FILE CR CW 01


STEAM PLANT
84" PUMP STATION
INLET ISOLATION
VALVE
DISCHARGE PIPE
VALVE VAULT "A"
96" C.W. INTAKE
ISOLATION VALVE
96" C.W. GRAVITY
RETURN ISOLATION
VALVE
VALVE VAULT "B"
84" C.W. DISCHARGE
ISOLATION VALVE
VALVE VAULT "C"
12" STEEL PIPE
MAKE-UP PUMPS
60" Ø CONCRETE EMERGENCY
OVERFLOW PIPE
COOLING WATER BOOSTER
PUMP STATION
ABOVE GROUND
UNDERGROUND
108" CONCRETE
DISCHARGE PIPE

SECTION

U. S. ARMY



LEGEND

-	EXISTING CONDITIONS
————	NEW EQUIPMENT, STRUCTURES & LINES
-E - -	ELECTRICAL LINES
O- -	OIL LINES
-P ---	OVERHEAD POWER LINES
G - -	GUY WIRES
—⋈—	ISOLATION VALVES (BUTTERFLY)
C W	COOLING WATER
● A1	AUGER SOIL BORING AND NUMBER
S1	CONTINUOUS SPLITSPOON SOIL BORING AND NUMBER

2

SCALE 1" = 50'

50 0 50 100

U. S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

STANLEY CONSULTANTS INC
CONSULTING ENGINEERS
ATLANTA GEORGIA

DESIGN MEMORANDUM 15
COOLING WATER FACILITIES

SITE LAYOUT
SHEET NO. 1

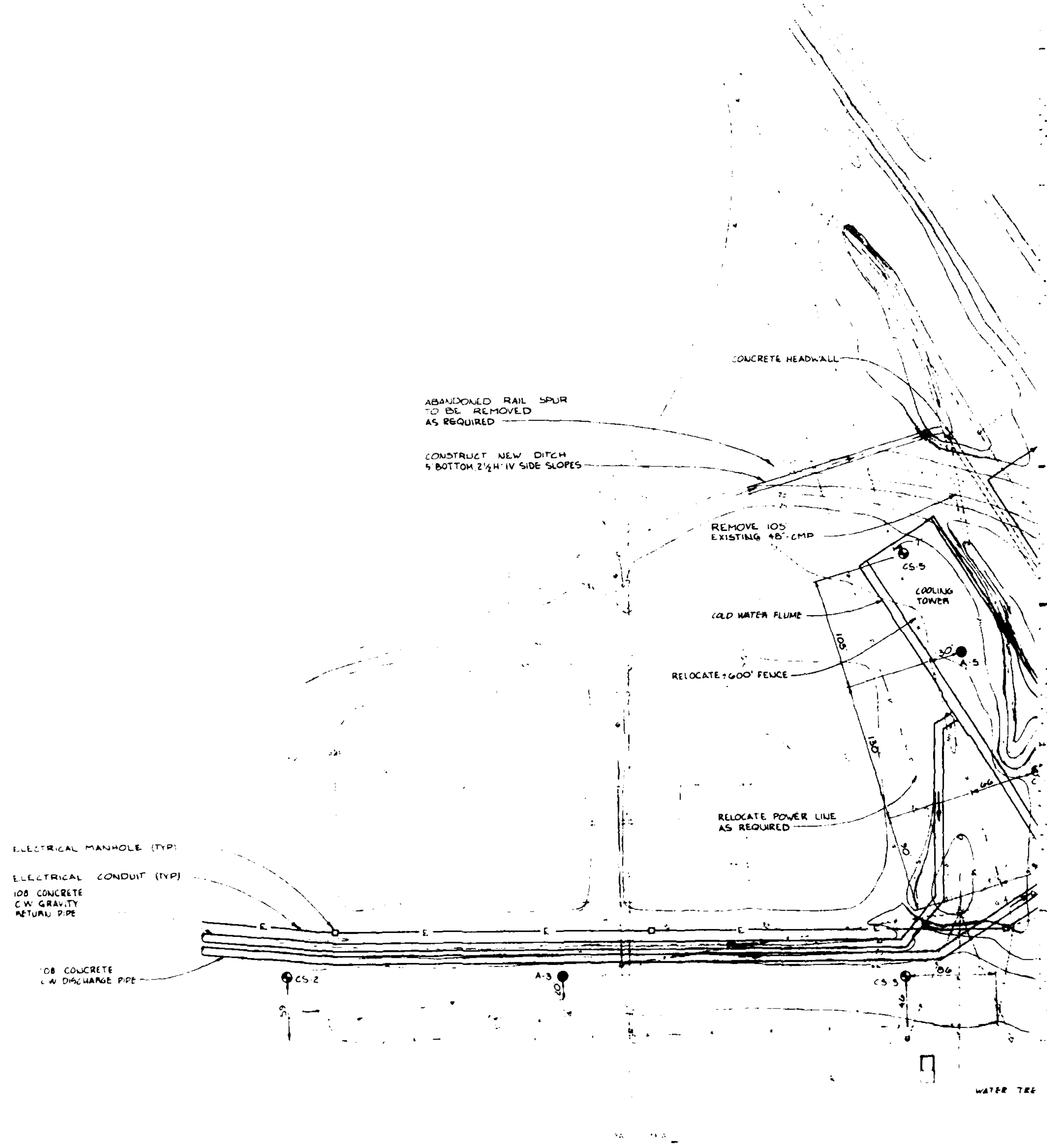
COOPER RIVER REDIVERSION PROJECT
LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA

SUBMITTED: CHIEF, GEOTECHNICAL SECTION — RECOMMENDED: CHIEF, DESIGN BRANCH

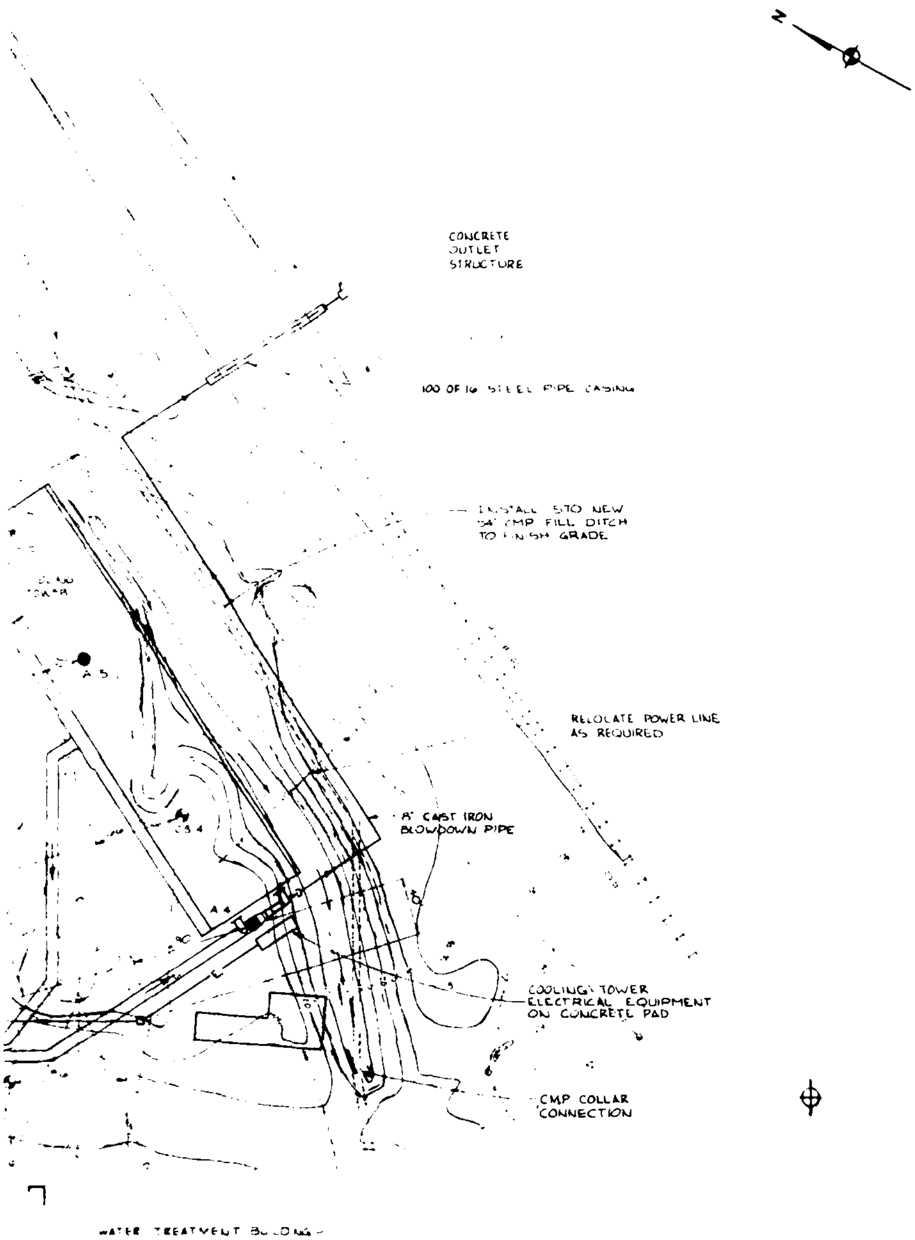
APPROVED: CHIEF, ENGINEERING DIVISION — APPROVED: COL. C.E., DISTRICT ENGINEER

SCALE: 1" = 50' | DATE: 22 SEPT 80 | FILE: CR CW 0-

PLATE 2


CONCRETE HEADWALL
ABANDONED RAIL SPUR
TO BE REMOVED
AS REQUIRED
CONSTRUCT NEW DITCH
5' BOTTOM, 2½H:1V SIDE SLOPES
REMOVE 105'
EXISTING 48" CMP
CS-5
COOLING
TOWER
COLD WATER FLUME
A-5
RELOCATE ±600' FENCE
RELOCATE POWER LINE
AS REQUIRED
ELECTRICAL MANHOLE (TYP)
ELECTRICAL CONDUIT (TYP)
108 CONCRETE
C.W. GRAVITY
RETURN PIPE
108 CONCRETE
C.W. DISCHARGE PIPE
CS-2
A-3
CS-3
WATER TRE

U. S. ARMY



NOTE

THE LAYOUT OF COOLING SYSTEM COMPONENTS ON THIS PLATE IS INTENDED FOR PRELIMINARY DESIGN AND ESTIMATING PURPOSES ONLY. FINAL LAYOUT WILL DEPEND ON AGENCY REVIEW COMMENTS, COOLING TOWER ACTUALLY SELECTED, UNDEVELOPED DESIGN DETAILS, AND A DETAILED INSTRUMENT SURVEY. MAJOR PIPING, ACCESS DRIVES, AND GRADING PLANS WILL BE COMPLETED WHEN LAYOUT IS FINALIZED.

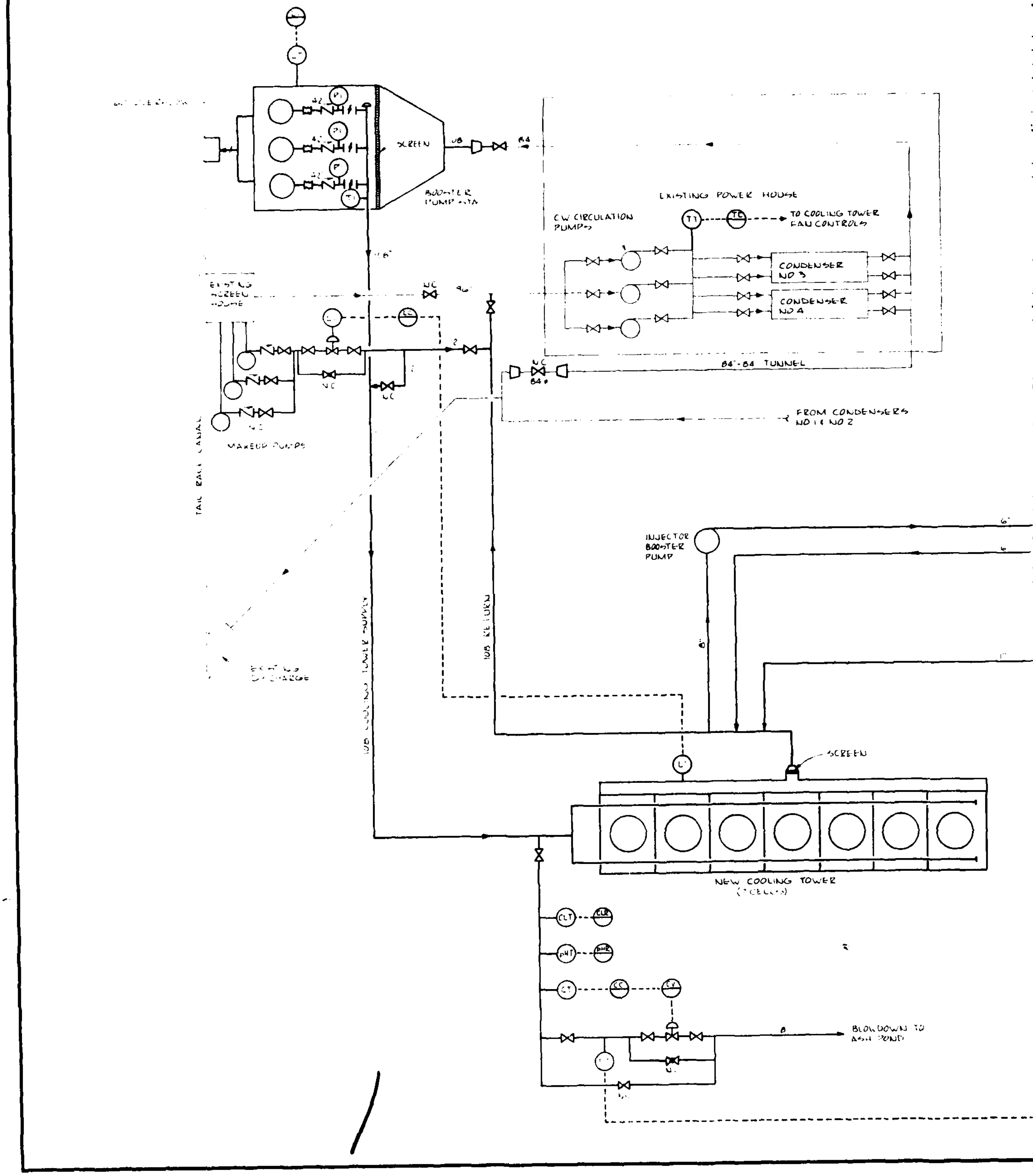
2

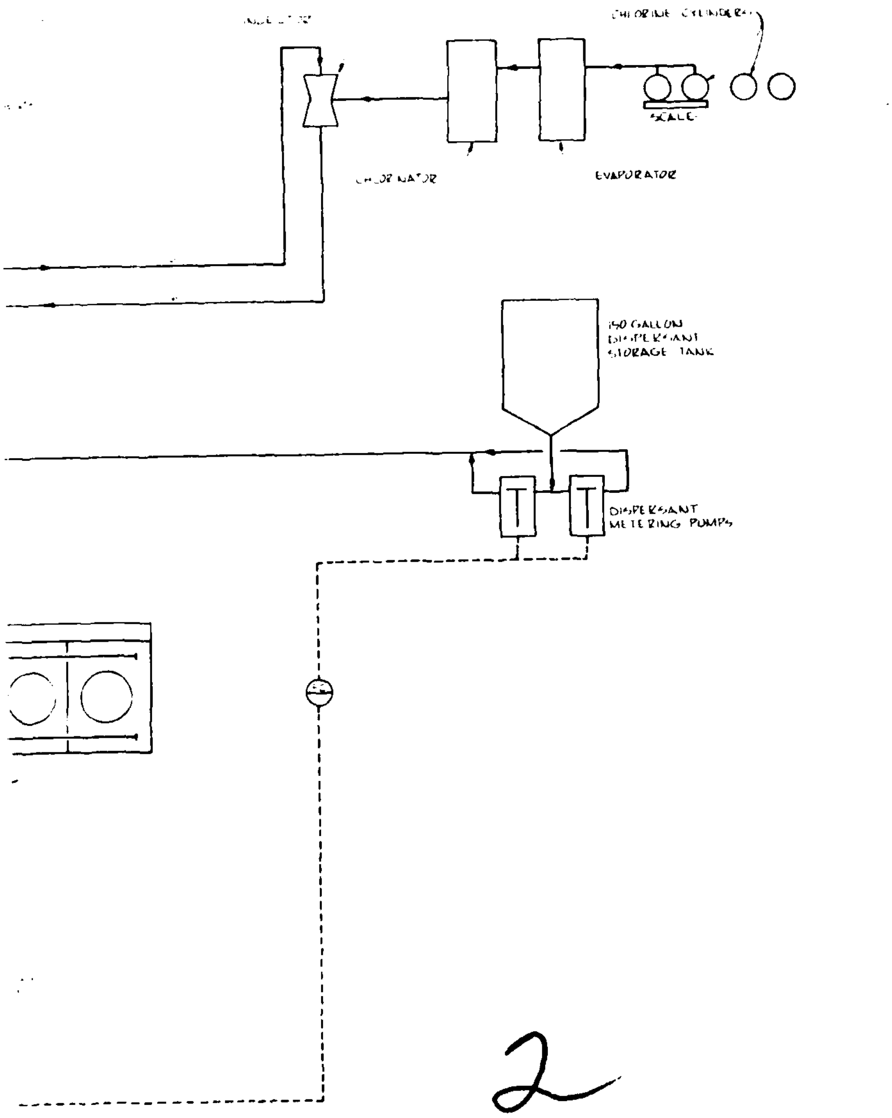
SCALE 1"=50
50 0 50 100

U. S. ARMY ENGINEER DISTRICT, SAVANNAH CORPS OF ENGINEERS SAVANNAH, GEORGIA	STANLEY CONSULTANTS INC CONSULTING ENGINEERS ATLANTA GEORGIA

DESIGN MEMORANDUM 13
COOLING WATER FACILITIES
SITE LAYOUT
SHEET NO. 2
COOPER RIVER REDIVERSION PROJECT
LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA

CHIEF, MECHANICAL SECTION	CHIEF, DESIGN BRANCH
CHIEF, ENGINEERING DIVISION	COL. C. O. E., DISTRICT ENGINEER
SCALE 1"=50	DATE 22 SEPT 80
FILE CR-CW-01	


SCREEN
BOOSTER PUMP STA
EXISTING POWER HOUSE
CW CIRCULATION PUMPS
TO COOLING TOWER FAN CONTROLS
CONDENSER NO 3
CONDENSER NO 4
84"-84 TUNNEL
FROM CONDENSERS NO 1 & NO 2
MAKEUP PUMPS
108 RETURN
INJECTOR BOOSTER PUMP
NEW COOLING TOWER
BLOWDOWN TO ASH POND

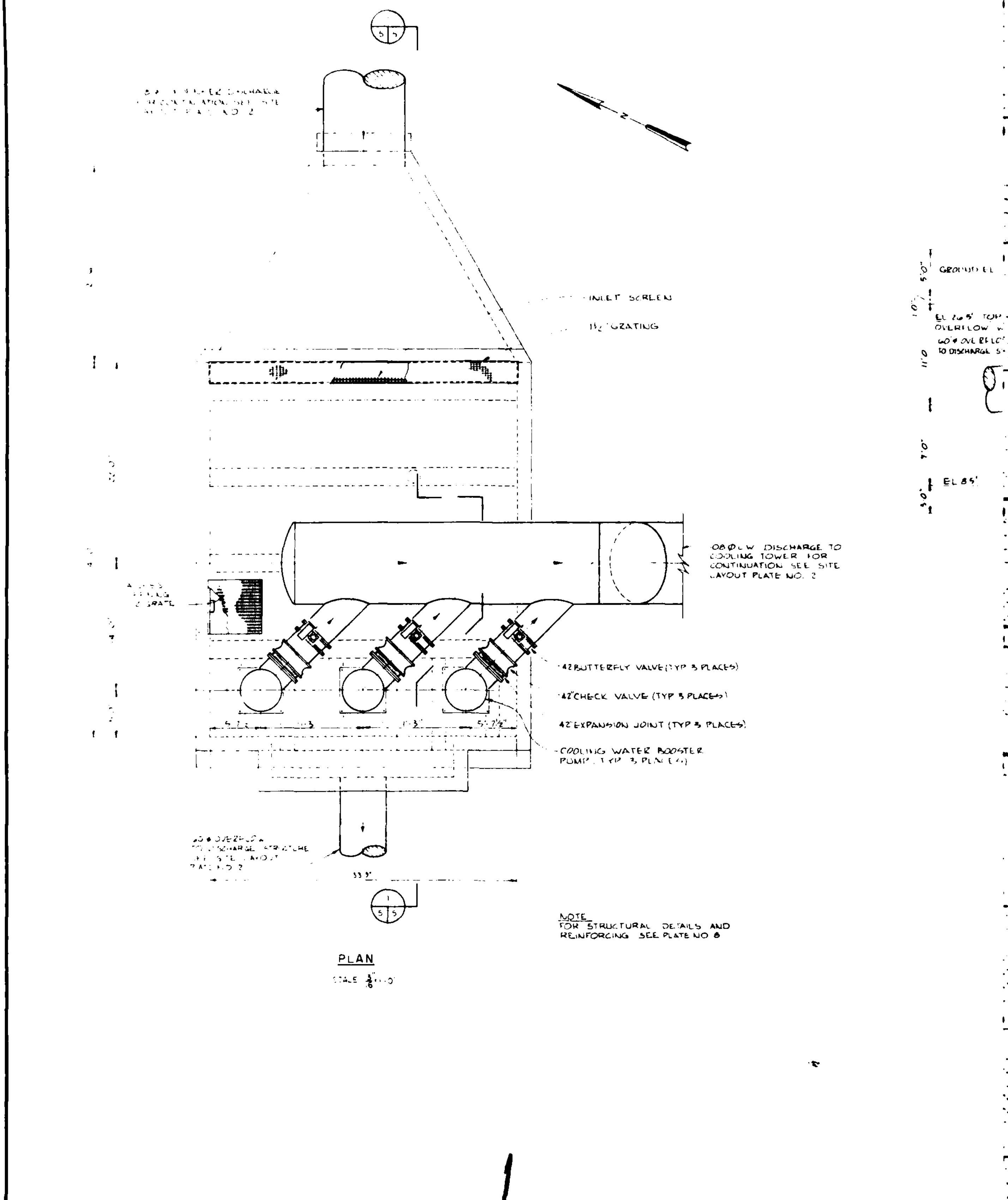


LEGEND

- EXISTING PIPING AND EQUIPMENT
- NEW PIPING AND EQUIPMENT
- NORMALLY CLOSED
- LOCALLY MOUNTED INSTRUMENT
- PANEL MOUNTED INSTRUMENT
- CLT — CHLORINE RESIDUAL TRANSMITTER
- CLR — CHLORINE RESIDUAL RECORDER WITH HIGH AND LOW LEVEL ALARMS
- CT — CONDUCTIVITY TRANSMITTER
- CR — CONDUCTIVITY RECORDER WITH HIGH AND LOW LEVEL ALARMS
- CC — CONDUCTIVITY CONTROLLER
- CV — BLOWDOWN CONTROL VALVE
- FC — FLOW CONTROLLER
- FT — FLOW TRANSMITTER
- LI — LEVEL INDICATOR WITH HIGH AND LOW LEVEL ALARMS
- LT — LEVEL TRANSMITTER
- LC — LEVEL CONTROLLER WITH HIGH AND LOW LEVEL ALARMS
- LV — LEVEL CONTROL VALVE
- PI — PRESSURE INDICATOR
- pHT — pH TRANSMITTER
- pHR — pH RECORDER WITH HIGH AND LOW LEVEL ALARMS
- TT — TEMPERATURE TRANSMITTER
- TC — TEMPERATURE CONTROLLER
- GATE VALVE
- GLOBE VALVE
- CONTROL VALVE
- CHECK VALVE
- EXPANSION JOINT
- BUTTERFLY VALVE

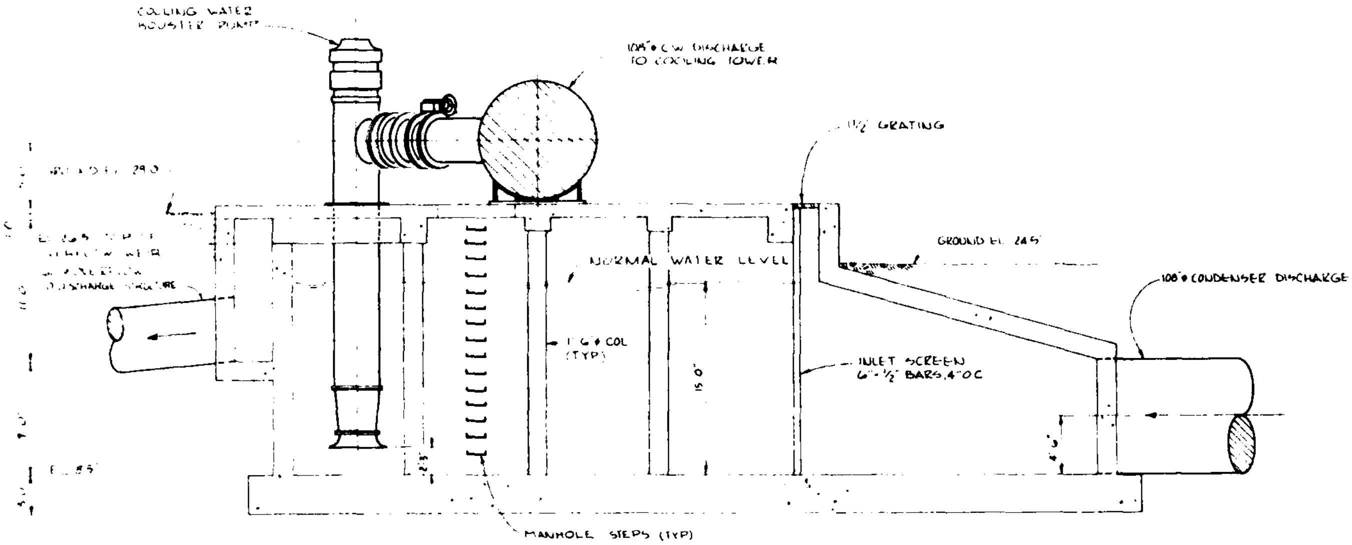
U S ARMY ENGINEER DISTRICT SAVANNAH CORPS OF ENGINEERS SAVANNAH GEORGIA	STANLEY CONSULTANTS INC CONSULTING ENGINEERS ATLANTA GEORGIA
DESIGN MEMORANDUM 15 ... WATER FACILITIES **COOLING WATER SYSTEM SCHEMATIC** COOPER RIVER REDIVERSION PROJECT LAKE MOULTRIE AND SANTEE RIVER — SOUTH CAROLINA	
SUBMITTED CHIEF ...	RECOMMENDED CHIEF DESIGN BRANCH
APPROVED CHIEF ENGINEERING DIVISION	APPROVED FOR C OF E DISTRICT ENGINEER
SCALE NONE | DATE ...	FILE ...

2


INLET SCREEN
GRATING
108" Ø C.W. DISCHARGE TO COOLING TOWER. FOR CONTINUATION SEE SITE LAYOUT PLATE NO. 2
42" BUTTERFLY VALVE (TYP 3 PLACES)
42" CHECK VALVE (TYP 3 PLACES)
42" EXPANSION JOINT (TYP 3 PLACES)
COOLING WATER BOOSTER PUMP (TYP 3 PLACES)
NOTE
FOR STRUCTURAL DETAILS AND REINFORCING SEE PLATE NO 8
GROUND EL
EL 85'

PLAN

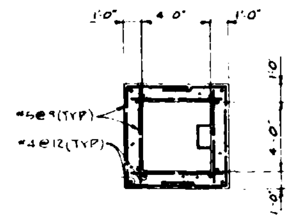
U. S. ARMY



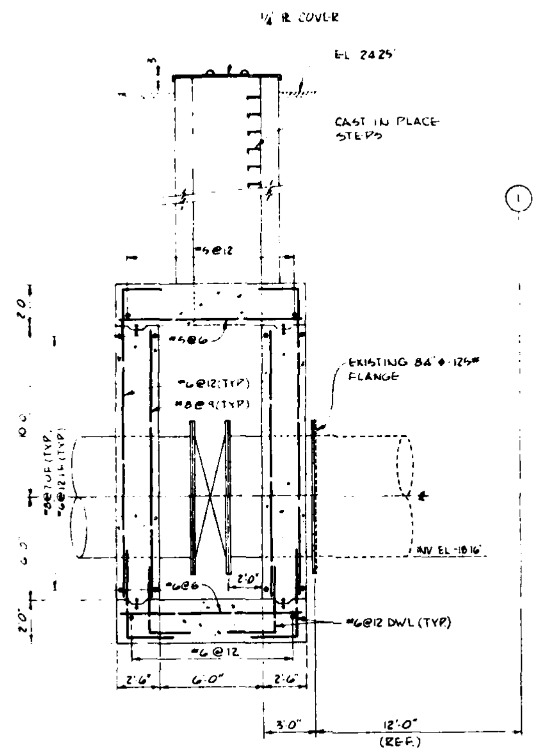
SECTION
SCALE 3/16"=1'-0"

2

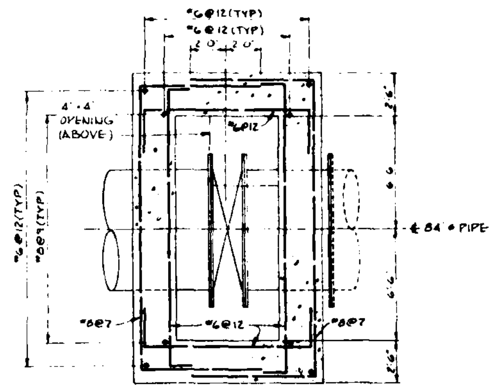
U.S. ARMY ENGINEER DISTRICT, SAVANNAH CORPS OF ENGINEERS SAVANNAH, GEORGIA	STANLEY CONSULTANTS INC CONSULTING ENGINEERS ATLANTA GEORGIA
DESIGN MEMORANDUM 13 COOLING WATER FACILITIES **PUMP STATION** **PLAN AND SECTION** COOPER RIVER REDIVERSION PROJECT LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA	
SUBMITTED: CHIEF, STRUCTURAL SECTION	RECOMMENDED: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION	APPROVED: COL. C OF E DISTRICT ENGINEER
SCALE	DATE



PLAN SECTION
TYPICAL MANHOLE OPENING
NO SCALE

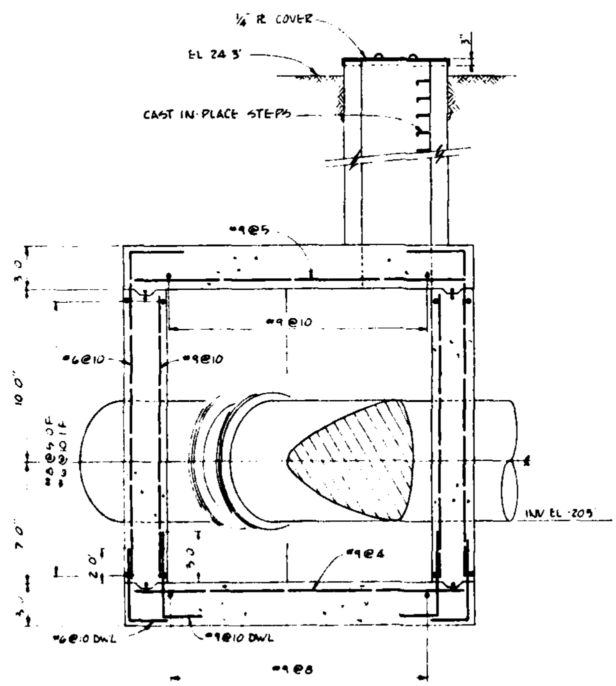


SECTION

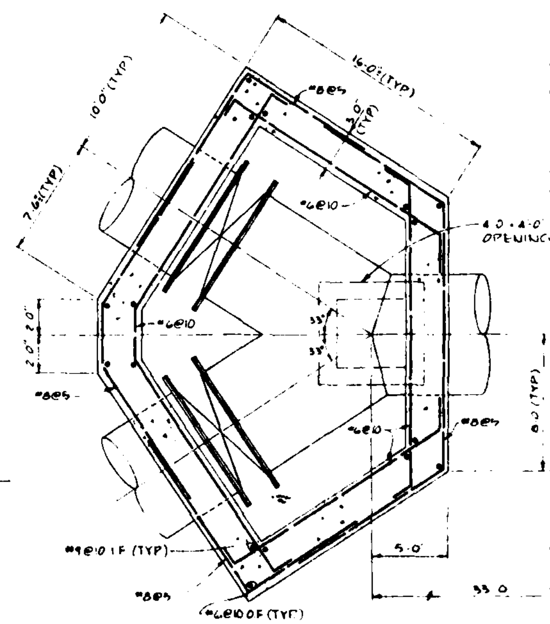


PLAN SECTION

VALVE VAULT "A"

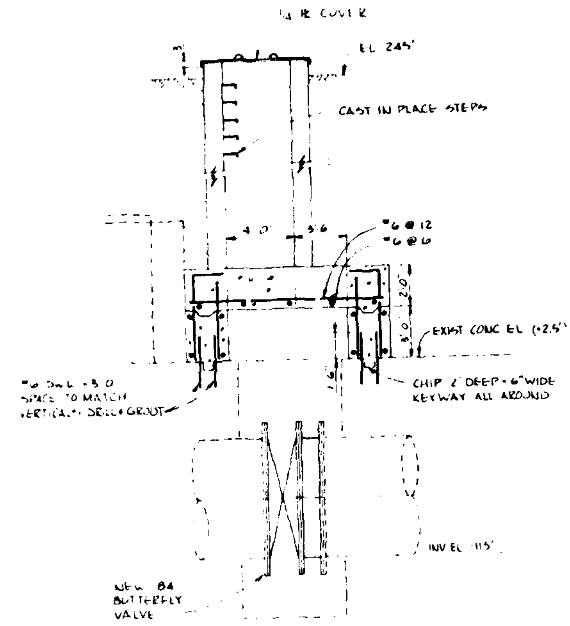


SECTION

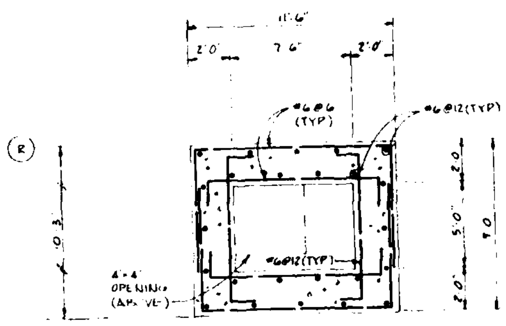


PLAN SECTION

VALVE VAULT "B"



SECTION



PLAN SECTION

VALVE VAULT "C"

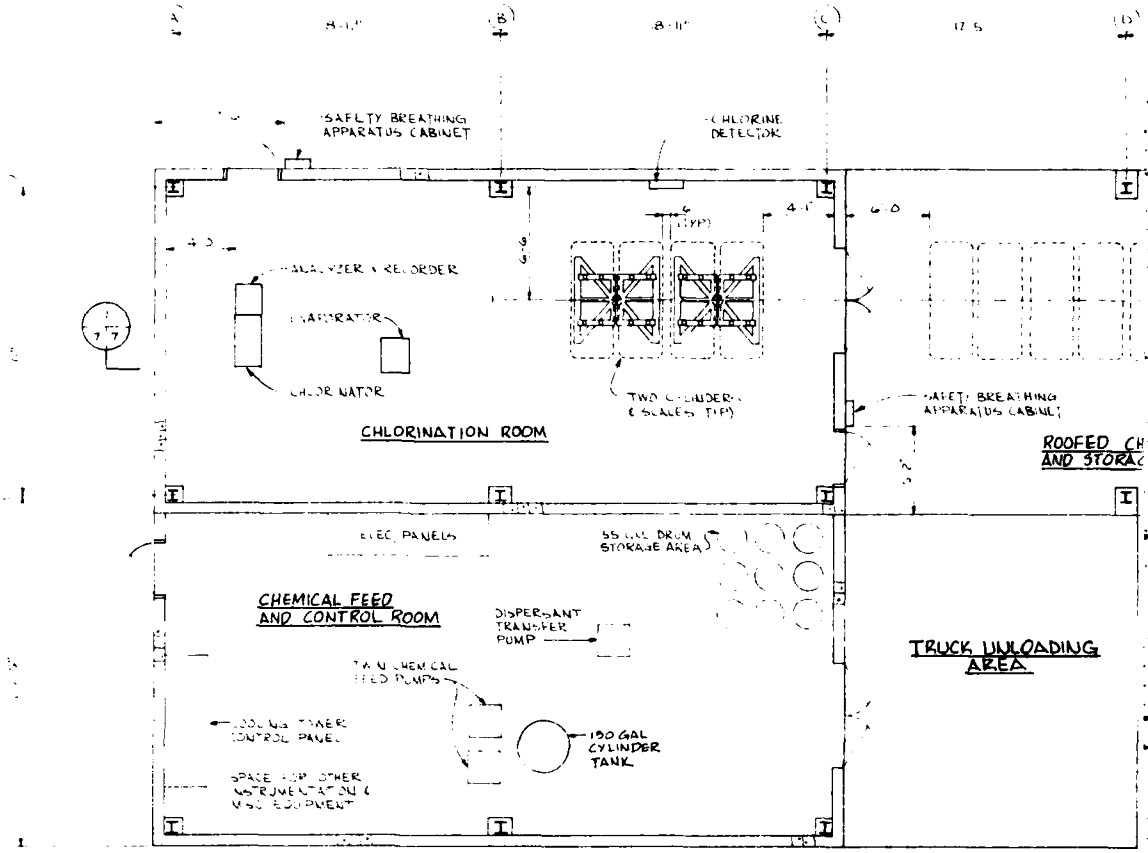
U S ARMY ENGINEER DISTRICT, SAVANNAH CORPS OF ENGINEERS SAVANNAH, GEORGIA	STANLEY CONSULTANTS INC CONSULTING ENGINEERS ATLANTA GEORGIA

DESIGN MEMORANDUM 13
COOLING WATER FACILITIES

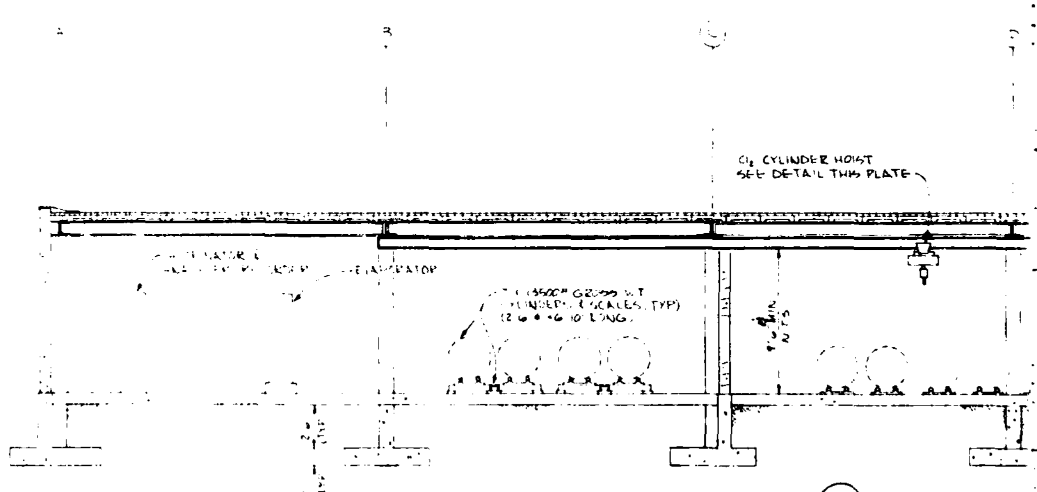
VALVE VAULT PLANS AND SECTIONS

COOPER RIVER REDIVERSION PROJECT
LAKE MOULTRIE AND SANTEE RIVER — SOUTH CAROLINA

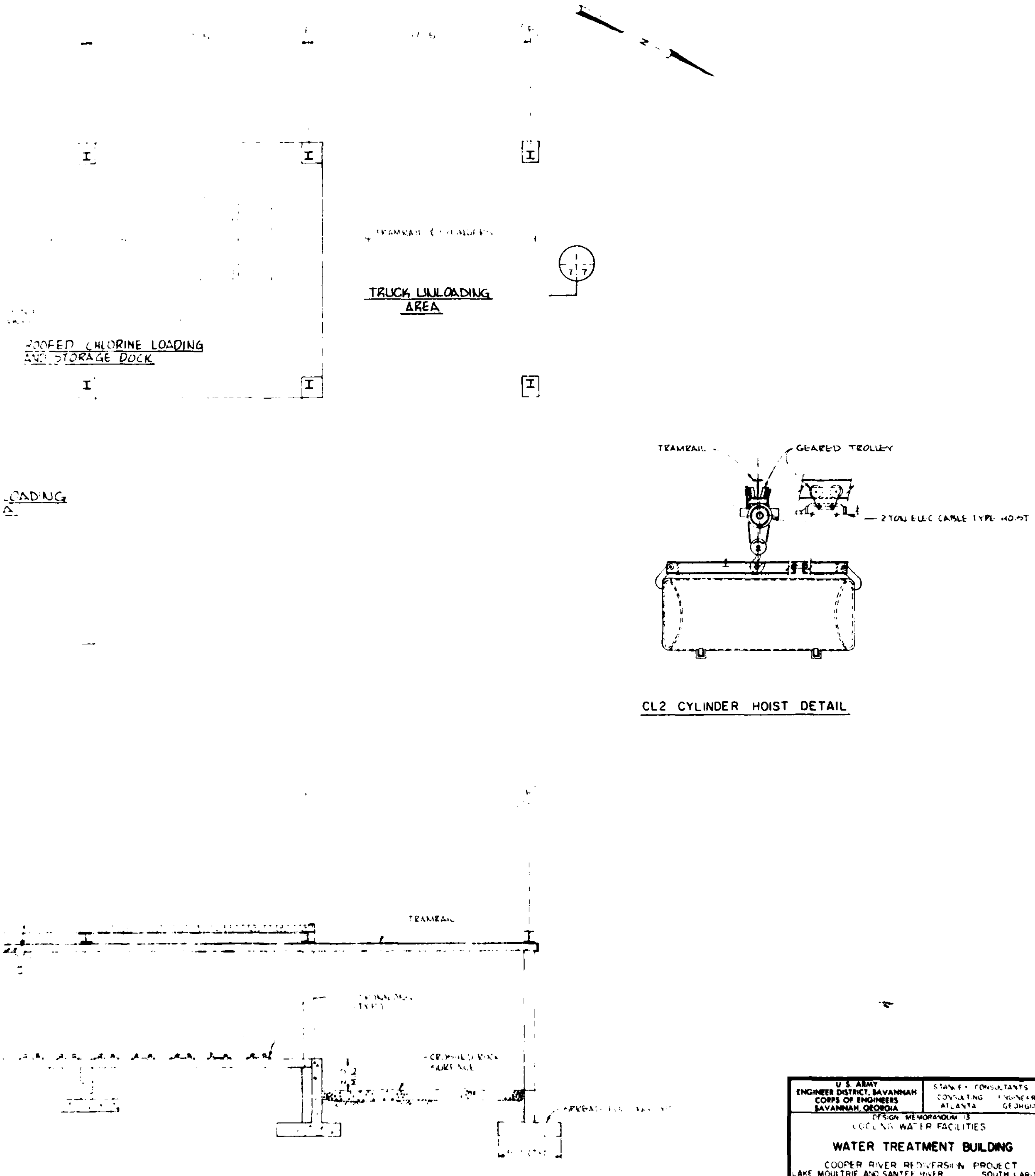
SUBMITTED: CHIEF, STRUCTURAL SECTION	RECOMMENDED: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION	APPROVED: COL, C OF E, DISTRICT ENGINEER
SCALE NONE	DATE 22 SEPT 80



FLOOR PLAN



SECTION



SCALE

U. S. ARMY ENGINEER DISTRICT, SAVANNAH CORPS OF ENGINEERS SAVANNAH, GEORGIA	CONSULTING ENGINEERS ATLANTA GEORGIA

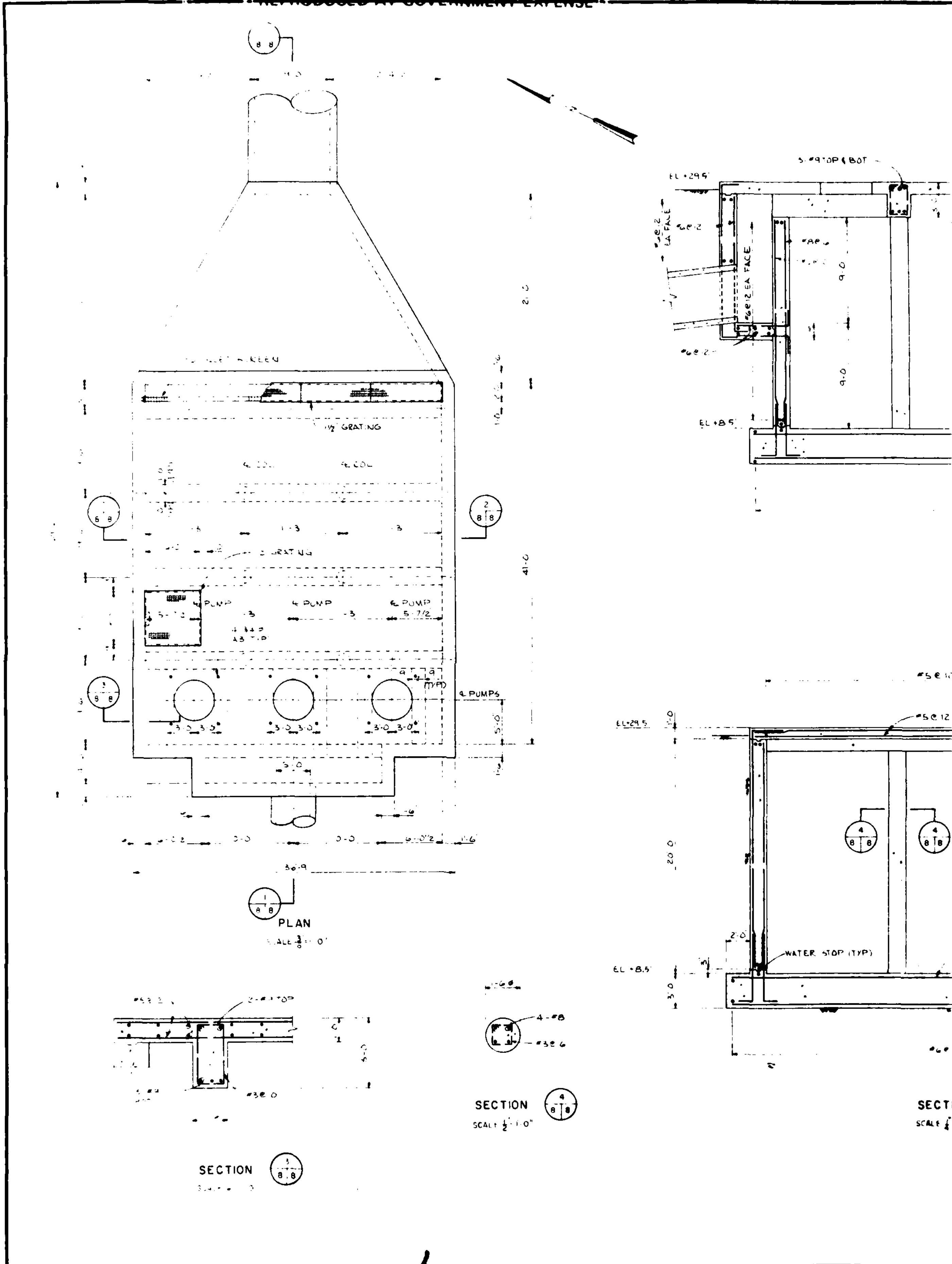
DESIGN MEMORANDUM

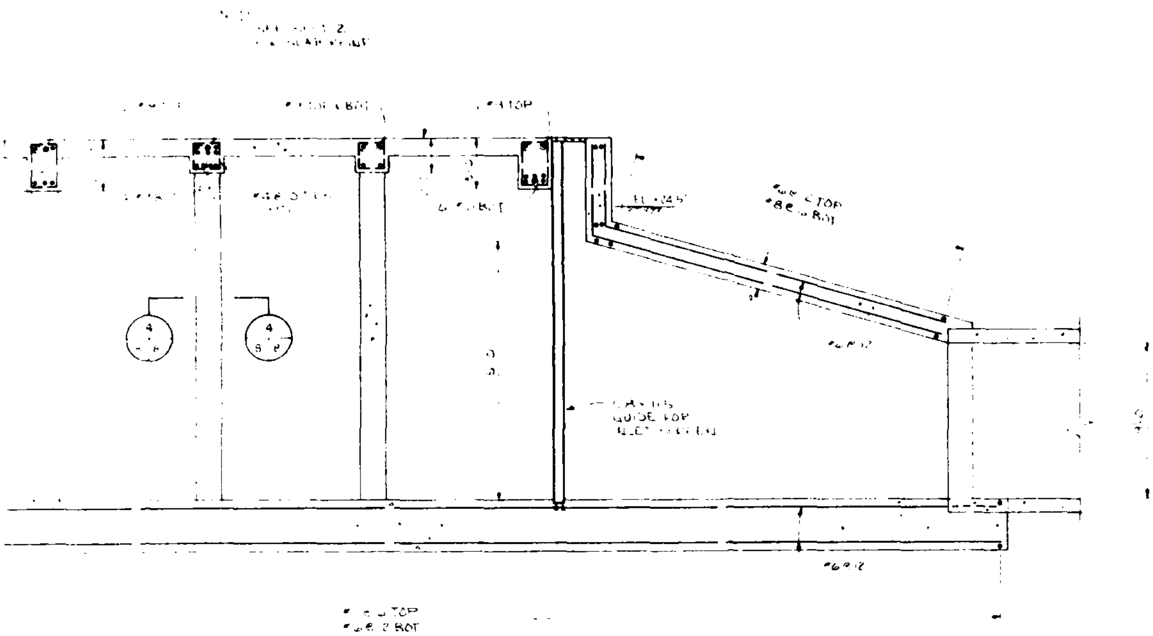
WATER FACILITIES

WATER TREATMENT BUILDING

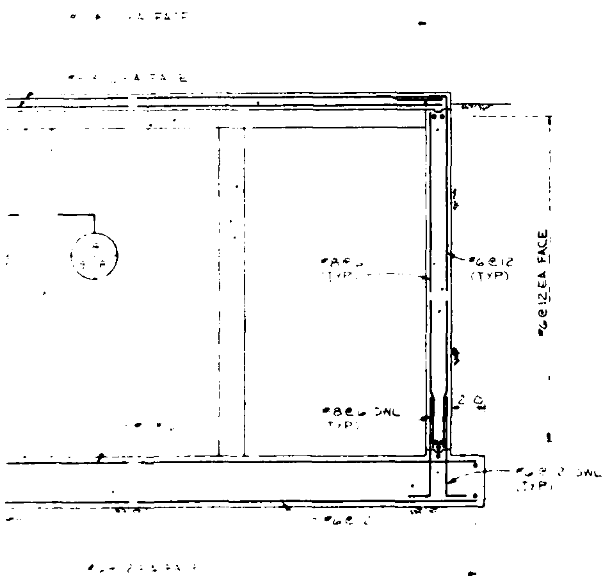
COOPER RIVER REDIVERSION PROJECT
LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA

SUBMITTED: CHIEF, STRUCTURAL SECTION	RECOMMENDED: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION	APPROVED: COL., C OF E, DISTRICT ENGINEER
SCALE	DATE


1 1/2" GRATING
℄ COL
℄ COL
℄ PUMP
℄ PUMP
℄ PUMP
5'-7/2
℄ PUMPS
(TYP)
3'-0 3'-0
3'-0 3'-0
3'-0 3'-0
5'-0
41'-0
36'-9
PLAN
EL +29.5'
5-#9 TOP & BOT
#6@12 EA FACE
#6@12 EA FACE
#6@12
9'-0
9'-0
EL +8.5'
EL +29.5
#5@12
20'-0
2'-0
WATER STOP (TYP)
EL +8.5'
3'-0
2-#8 TOP
#3@6
4-#8
#3@6
SECTION
SCALE 1/2" = 1'-0"
SECTION
SECT



SECTION



SECTION

SCALE $\frac{3}{16}$" = 1'-0" SCALE $\frac{1}{4}$" = 1'-0" SCALE $\frac{3}{8}$" = 1'-0"

U. S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

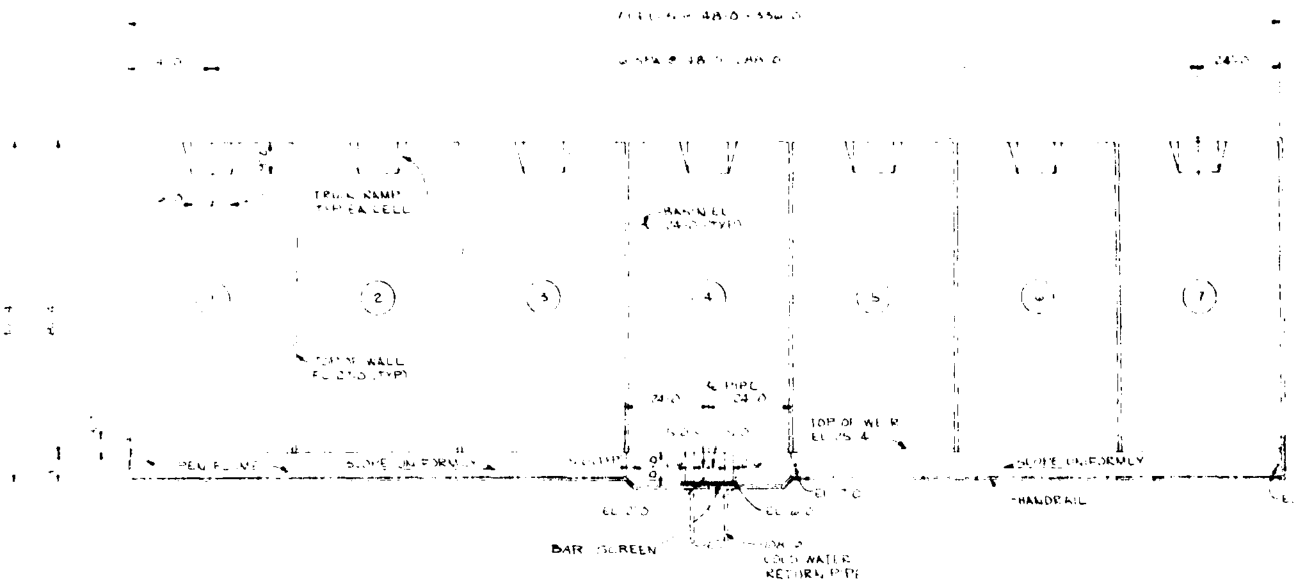
STANLEY CONSULTANTS INC
CONSULTING ENGINEERS
ATLANTA GEORGIA

DESIGN MEMORANDUM 13
COOLING WATER FACILITIES
PUMP STATION FOUNDATION
PLAN AND SECTIONS
COOPER RIVER REDIVERSION PROJECT
LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA

CHIEF, STRUCTURAL SECTION
CHIEF, DESIGN BRANCH
APPROVED
APPROVED
COL, C OF E, DISTRICT ENGINEER
SCALE: AS NOTED DATE: 27 SEPT 80

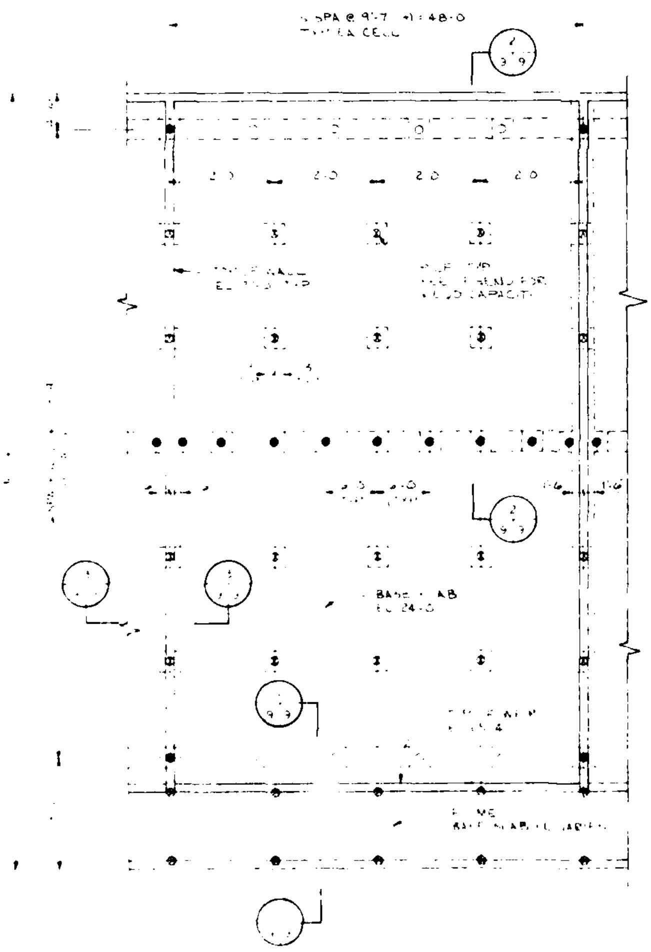
2

PLATE-8

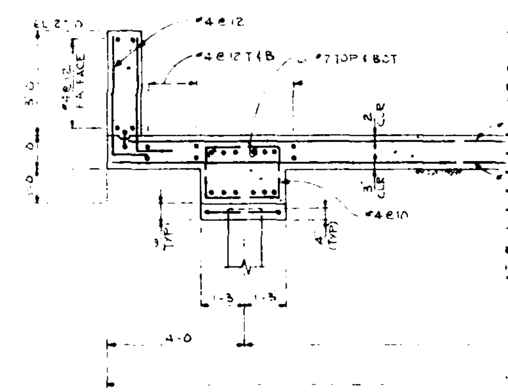


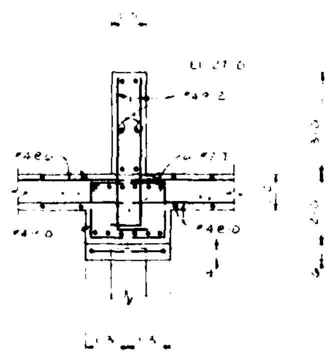
COOLING TOWER BASIN PLAN

SCALE 1:20



PARTIAL BASIN PLAN

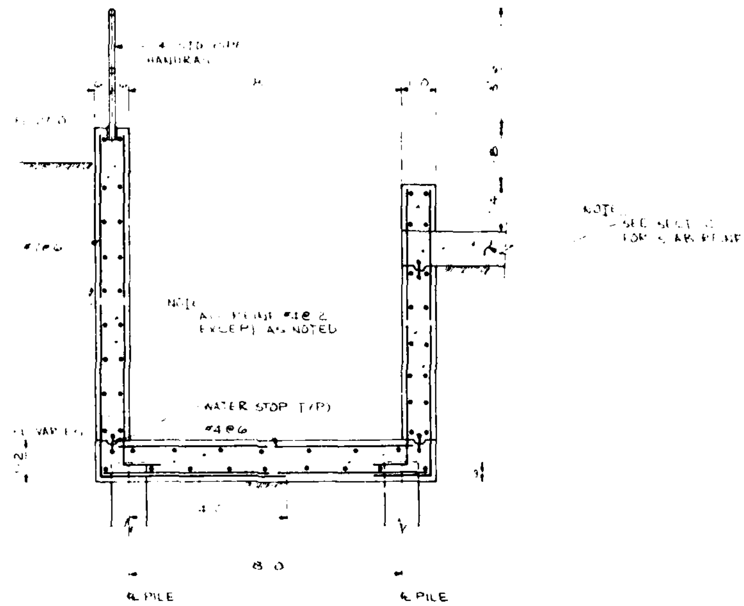




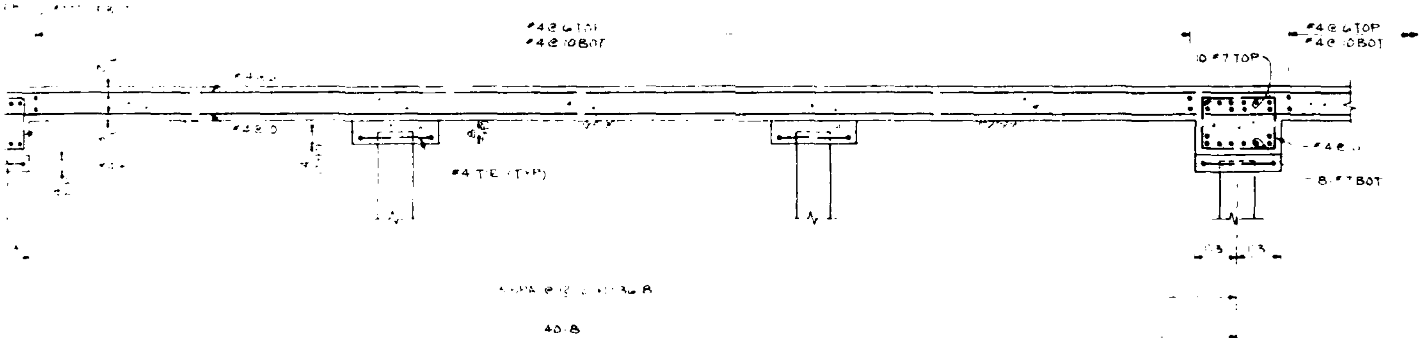
SECTION

SCALE 1/2" = 1'-0"

U. S. ARMY



SECTION



SECTION

LEGEND
⊗ 40 TON PILEING
○ 60 TON PILEING
● 90 TON PILEING

U. S. ARMY ENGINEER DISTRICT, SAVANNAH CORPS OF ENGINEERS SAVANNAH, GEORGIA	STANLEY CONSULTANTS INC CONSULTING ENGINEERS ATLANTA GEORGIA

DESIGN MEMORANDUM 13
COOLING WATER FACILITIES
COOLING TOWER BASIN
FOUNDATION PLAN & SECTIONS
COOPER RIVER REDIVERSION PROJECT
LAKE MOULTRIE AND SANTEE RIVER — SOUTH CAROLINA

SUBMITTED:	RECOMMENDED:
CHIEF, STRUCTURAL SECTION	CHIEF, DESIGN BRANCH
APPROVED:	APPROVED:
CHIEF, ENGINEERING DIVISION	COL., C. OF E., DISTRICT ENGINEER
SCALE AS NOTED	DATE 22 SEPT 80

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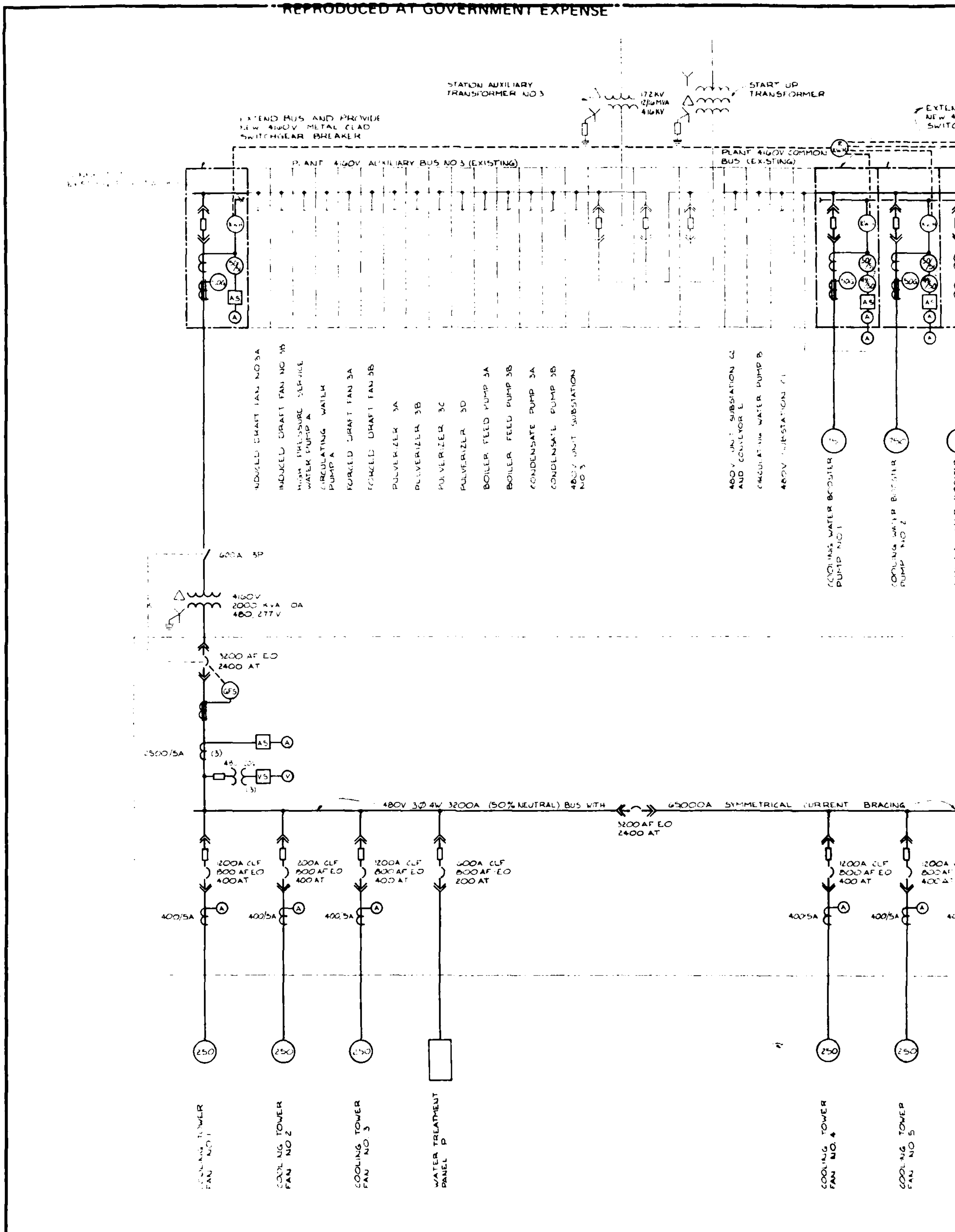
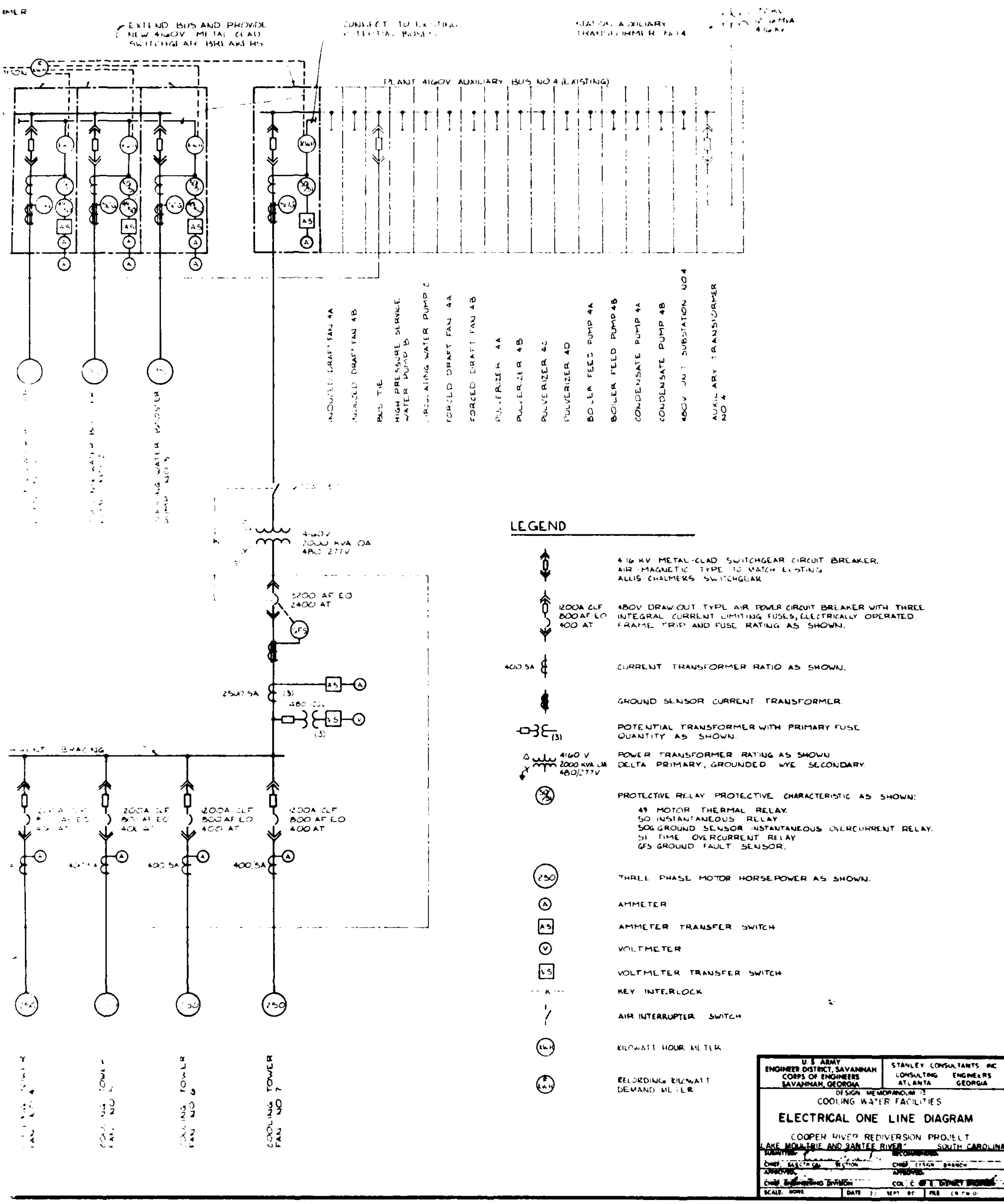

STATION AUXILIARY TRANSFORMER NO 3
START UP TRANSFORMER
EXTEND BUS AND PROVIDE NEW 4160V METAL CLAD SWITCHGEAR BREAKER
PLANT 4160V AUXILIARY BUS NO 3 (EXISTING)
PLANT 4160V COMMON BUS (EXISTING)
INDUCED DRAFT FAN NO 3A
INDUCED DRAFT FAN NO 3B
HIGH PRESSURE SERVICE WATER PUMP A
CIRCULATING WATER PUMP A
FORCED DRAFT FAN 3A
FORCED DRAFT FAN 3B
PULVERIZER 3A
PULVERIZER 3B
PULVERIZER 3C
PULVERIZER 3D
BOILER FEED PUMP 3A
BOILER FEED PUMP 3B
CONDENSATE PUMP 3A
CONDENSATE PUMP 3B
480V UNIT SUBSTATION NO 3
480V UNIT SUBSTATION AND CONVEYOR E
CIRCULATING WATER PUMP B
COOLING WATER BOOSTER PUMP NO 1
COOLING WATER BOOSTER PUMP NO 2
600A 3P
4160V
2000 KVA OA
480/277 V
3200 AF EO
2400 AT
GFS
2500/5A
(3)
AS
VS
480V 3Ø 4W 3200A (50% NEUTRAL) BUS WITH 65000A SYMMETRICAL CURRENT BRACING
3200 AF EO
2400 AT
1200A CLF
800 AF EO
400 AT
600A CLF
800 AF EO
200 AT
400/5A
250
COOLING TOWER FAN NO 1
COOLING TOWER FAN NO 2
COOLING TOWER FAN NO 3
WATER TREATMENT PANEL P
COOLING TOWER FAN NO 4
COOLING TOWER FAN NO 5


EXTEND BUS AND PROVIDE NEW 4160V METAL CLAD SWITCHGEAR BREAKERS
PLANT 4160V AUXILIARY BUS NO.4 (EXISTING)
INDUCED DRAFT FAN 4A
INDUCED DRAFT FAN 4B
BUS TIE
HIGH PRESSURE SERVICE WATER PUMP B
CIRCULATING WATER PUMP C
FORCED DRAFT FAN 4A
FORCED DRAFT FAN 4B
PULVERIZER 4A
PULVERIZER 4B
PULVERIZER 4C
PULVERIZER 4D
BOILER FEED PUMP 4A
BOILER FEED PUMP 4B
CONDENSATE PUMP 4A
CONDENSATE PUMP 4B
480V UNIT SUBSTATION NO4
AUXILIARY TRANSFORMER NO 4
4160V
2000 KVA OA
480/277V
3200 AF EO
2400 AT
2500:5A
1200A CLF
800 AF EO
400 AT
400:5A
250
COOLING TOWER FAN NO 7
LEGEND
4.16 KV METAL-CLAD SWITCHGEAR CIRCUIT BREAKER, AIR-MAGNETIC TYPE TO MATCH EXISTING ALLIS CHALMERS SWITCHGEAR
480V DRAW OUT TYPE AIR POWER CIRCUIT BREAKER WITH THREE INTEGRAL CURRENT LIMITING FUSES, ELECTRICALLY OPERATED. FRAME, TRIP AND FUSE RATING AS SHOWN.
CURRENT TRANSFORMER RATIO AS SHOWN.
GROUND SENSOR CURRENT TRANSFORMER.
POTENTIAL TRANSFORMER WITH PRIMARY FUSE QUANTITY AS SHOWN.
POWER TRANSFORMER RATING AS SHOWN DELTA PRIMARY, GROUNDED WYE SECONDARY.
PROTECTIVE RELAY PROTECTIVE CHARACTERISTIC AS SHOWN:
49 MOTOR THERMAL RELAY.
50 INSTANTANEOUS RELAY.
50G GROUND SENSOR INSTANTANEOUS OVERCURRENT RELAY.
51 TIME OVERCURRENT RELAY
GFS GROUND FAULT SENSOR.
THREE PHASE MOTOR HORSEPOWER AS SHOWN.
AMMETER
AMMETER TRANSFER SWITCH
VOLTMETER
VOLTMETER TRANSFER SWITCH
KEY INTERLOCK
AIR INTERRUPTER SWITCH
KILOWATT HOUR METER
RECORDING KILOWATT DEMAND METER
U.S. ARMY ENGINEER DISTRICT, SAVANNAH CORPS OF ENGINEERS SAVANNAH, GEORGIA
STANLEY CONSULTANTS INC CONSULTING ENGINEERS ATLANTA GEORGIA
DESIGN MEMORANDUM 13
COOLING WATER FACILITIES
ELECTRICAL ONE LINE DIAGRAM
COOPER RIVER REDIVERSION PROJECT
LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA

2

PLATE

END

FILMED

5-85

DTIC